Price of this book : Hfl.

A publication of Philips I&E

Test and Measurement - Training

Printed in the Netherlands

This course is primary designed as a "class-room" course.

In this way you will get the maximum benefit, having

immediate assistance of your teacher to assist you going

through the principles related exercizes.

The majority of subjects treated, are supported by measuring

exersizes; learn by doing !

Digital Storage Oscilloscopes
principles and operation

1.1 INTRO DSO principles
  use of DSO's
  a dso digitize the signals
    (amplitude in time conversion)
  basic elements of a DSO

* <u>ANALOG TO DIGITAL CONVERSION</u>
  Real time Sampling
    sample rate
    under sampling causes aliasing
    <u>DEMO/HANDS-ON</u>
      autoset
      dots aliasing [gen]/[DigCountCircuit,d1]
  vertical resolution
    digits numbers
  ADC summary
    Don't miss the details
  P2CCD
    zero drop
    <u>DEMO/HANDS-ON</u>
      Direct sampling versus P2CCD sampling
  Bandwidth in DSO's : Single Shot

* <u>PRE/POST TRIGGER DELAY : Far away from the trigger point</u>
  Pre-post triggering delay
  Pre-post triggering delay
  acquisition control
    go into detail (All,MFDSO)
    zoom into details (All)
    Digitally delayed time base
      auto zoom (PM3350A/3375)
    acquisition control (PM3340 only)
  triggering set up, triggerview (MFDSO,all).
  <u>DEMO/HANDS-ON</u>
    manual trigger set up
    manual zoom into details
    centre / reverse / restart
    AUTOZOOM (PM3350A/3375) [ChopTargetId]

* <u>ROLL MODE : Watchdog on slow moving signals</u>
  roll mode versus recurrent mode
  Triggered roll
  <u>DEMO/HANDS-ON</u>
    roll mode
    trigger stop with trigger delay [DC-potm]

* <u>SINGLE/MULTIPLE MODE : Capture a single</u>
  Mode's (MFDSO)
  Mode's (PM3320A/40)
  Multiple mode memory use
    Store to memory (MFDSO)
    Multiple registers
    choice out of 3 registers, shift registers (MFDSO)
  capture single events and PLOT them (All?)
  <u>DEMO/HANDS-ON</u>
    capture special signals [Telph][Mic]

1.2 Signal acquisition

Digitizing (REAL time) (All)
Repetitive sampling
  Sequential (PM3340,PM3355/3365A)
  Random (PM3320A/3323)

overview acquisition modes
    PM3350A/75 and PM3335
    Digitizing with max resolution (PM3320A/23)
    PM3320A/3323/3340

2.0 Processing (PM3350A/3375)

* <u>CURSOR CONTROLLED MEASUREMENTS : don't gamble , measure !</u>
    - intelligent cursors
    - Cursor readout
    - cursor controlled measurements
    - measurements in V and Time
    - calculations
        - position cursors
    - Accuracy
        - vertical
        - horizontal
    - <u>DEMO/HANDS-ON</u>
        - Vpp Freq of a square wave and it's ringing. [DigCount][Pulser]
        - (Vrms and Vmean // V abs consequences)

* <u>ENVELOPE MODE : Jitter measurement</u>
    - Envelope
    - envelope example
    - <u>DEMO/HANDS-ON</u>
        - capture and measure jitter [Target+Gen10KHz]
        - locate Glitches [Tek-Kit]

* <u>Detections of Glitches</u>
        - ...

* <u>AVERAGE MODE : Clean up your signal</u>
    - Averaging
    - average in recurrent mode
    - ! average in SINGLE shot mode
    - <u>DEMO/HANDS-ON</u>
        - clean-up a signal [saw tooth target]
        - ! capture a single in Average Mode [....]

! NOT YET AVAILABLE

3.0 Interfacing (MFDSO series)
Remote control (all)

* <u>HARD</u> <u>COPY</u>
Hard copy output
example plot
setup system for Plotting/Printing
Reproduce for testing [PM5138]

* <u>AUTOMATION</u> <u>(ATE)</u>
<u>Frontpanel</u> <u>setting</u> / <u>GPIB</u> <u>control</u>
QUICK setup of front settings
Front panel settings
<u>DEMO</u> / <u>HANDS-ON</u>
Frontpanel save and recall
some extra steps to make for the CURSORS
Fronts on the PM3320A series
GPIB software : 2 product lines
BINPROG
Create for reproduction

CHAPTER 1

DIGITAL STORAGE OSCILLOSCOPES

PRINCIPLES AND OPERATION

1.1. INTRODUCTION TO DSO PRINCIPLES

DIGITAL STORAGE SCOPES

Figure 1-1

PREFACE: DIGITAL STORAGE OSCILLOSCOPES

Those involved in measuring the voltage or frequency of waveforms will already be familiar with the analog oscilloscopes widely used for many different applications, in many different industries.

As technology improves, more demands are made on the instruments needed to probe high tech equipment. Needless to say, oscilloscopes have improved to match these advances. One of the major changes has been the development of the Digital Storage Oscilloscope, or DSO, which enables a user to capture a waveform on-screen without the clumsy procedure of photographing it.

The following slides will introduce the digital storage oscilloscope, highlight the major specifications, and point out how you can avoid potential pitfalls when working with DSOs. And even if you have already used a DSO, a basic refresher on understanding digital storage techniques will help you select the correct DSO for your application and make better use of its full capabilities.

The course material falls into two main sections:

1. INTRODUCING DSO PRINCIPLES, covering the circuit techniques used in DSOs,
2. DIGITISING SIGNALS, covering the methods by which signals are sampled for digitising.

USE of DSO's

ANALYSE SIGNAL WAVEFORM (digital stored)

BY

- accurate TIME and VOLTAGE MEASUREMENTS
- Calculating of the characteristics
  - like Vpp Trise Vrms Freg Period ...
- ANALYSING and PROCESSING the waveform data
  - like ADD SUB INT DIFF HISTOGRAM FFT .....
- TRANSFER of DATA from and to EXTERNAL SOURCES
  - plotters printers modems ....
- PROCESS of DATA external by a PC or CONTROLLER
  - OSP ...

CAPTURE SINGLE EVENTS AND STORE THEM FOREVER

Figure 1-2

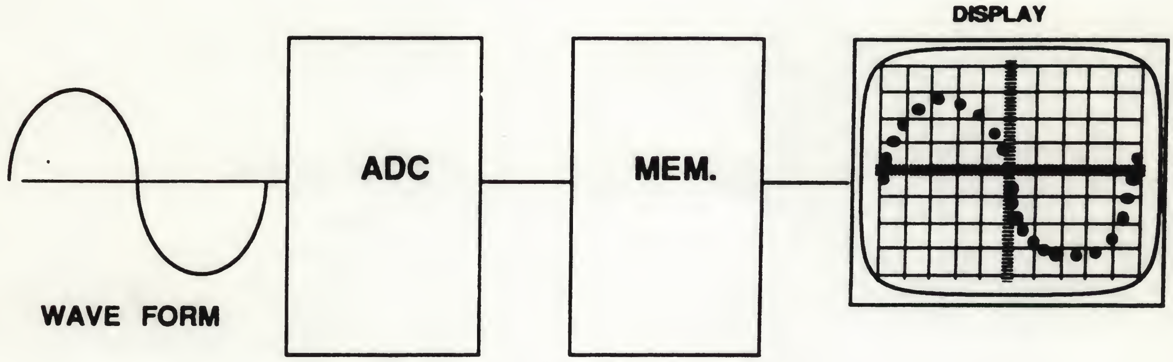
1. INTRODUCING DSO PRINCIPLES

1.1 USE OF DSOs (Fig. 1-2)

The main use of DSOs is to capture single events or pulse bursts in applications such as destructive testing, ballistics, or engine testing. Once the waveform is captured, it can be stored indefinitely as long as power is applied to the memories, which gives a DSO its 'non-volatile' capability. Digital storage is foreverl

A DSO brings many other benefits. It allows you to make accurate time and fequency measurements without the need for a separate timer/counter, because the timing circuits are locked on to a stable crystal oscillator. Analog 'scopes on the other hand use analog oscillators, which can drift. Furthermore, a DSOs microcomputer can calculate parameters of the waveform that it has stored in its memory, or can transfer the information in digital form to a controller or personal computer to make the calculations. Features such as these have led to DSOs taking over from analog oscilloscopes in many applications.

A DSO DIGITIZE THE SIGNALS



*** IT SAMPLE's THE WAVE FORM IN TIME, AND STORES IT TO A MEM.**

*** IT RECONSTRUCT THE WAVE FORM FOR DISPLAYING**

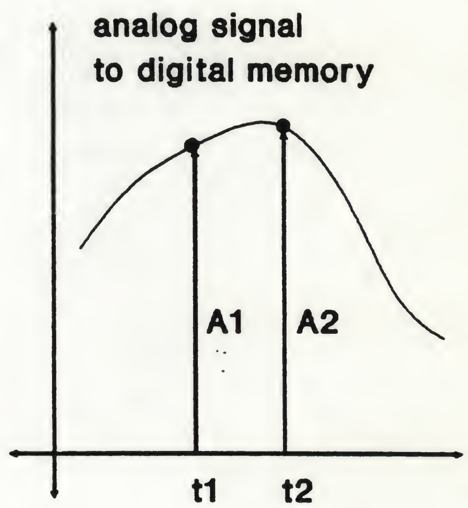
Figure 1-3

1.2 THE DIGITISING TECHNIQUE (Fig. 1-3)

Although DSOs have many more possibilities than analog oscilloscopes, they are still similar in many ways to their analog counterparts, particularly in the way they are operated.

However, a DSO processes the incoming waveform in a completely different way to an analog oscilloscope.

At any instant, a waveform will have a particular value of amplitude. If you draw a waveform on a sheet of graph paper, then the values of amplitude could be easily calculated where the waveform crosses the graph lines. Similarly, a DSO samples the waveform in time, and stores these discrete values in digital form for later construction, to give the impression of a continuous waveform on the display. This is rather like taking snapshots of the waveform at regular intervals using a movie camera, and then playing back the film to show continuous movement. However, unl;ike a film, the DSO records the values of amplitude at any point as a digital word.
Obviously, the more samples, the better the representation.



A1 : Analog -> Digital

t1 : time -> place in Mem

BASIC ELEMENTS OF A DSO

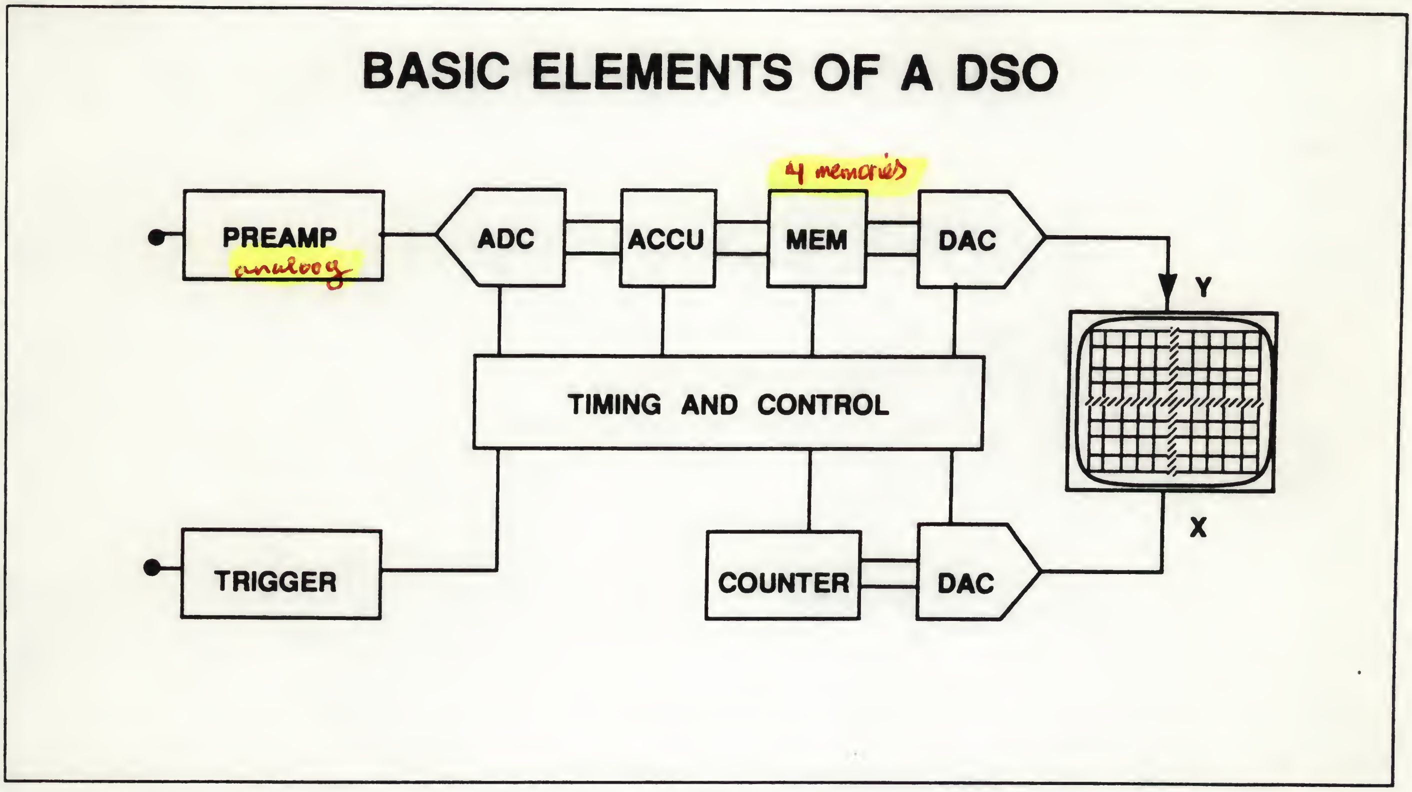


Figure 1-4

1.3 BASIC ELEMENTS OF A DSO (Fig. 1-4)

The *basic elements* found in any DSO are shown on the simplified block diagram, Fig. 1-4.
The incoming analog signal enters the DSO via an attenuator and signal conditioning circuits (including protection circuits, filters, etc.).

Inside the DSO, the **A-D CONVERTER (ADC)** converts the waveform into digital form and the **ACQUISITION MEMORY (ACCU)** stores it temporarily before passing it to the **DISPLAY AND STORAGE MEMORY**.
Most DSOs still use the conventional XY displays of an analog 'scope. So to display the waveform on screen it must first be reconverted to analog form using a **D-A CONVERTER.** The output from this converter represents the amplitude of the waveform and is fed to the Y plates of the CRT. Similarly, the output of the 'scope's **COUNTER** section is converted to an analog sawtooth wave suitable to drive the X plates of the CRT to provide the timebase.

Finally, the **TIMING** section ensures that the correct portion of the waveform is displayed on the screen, and that all the sections for waveform acquisition and reconstruction work together properly.

BASIC ELEMENTS of DSO's

. ADC
→Sample rate
→vertical resolution

most critical

. ACCU

. MEM

. DAC

. TIMING AND CONTROL

Figure 1-5

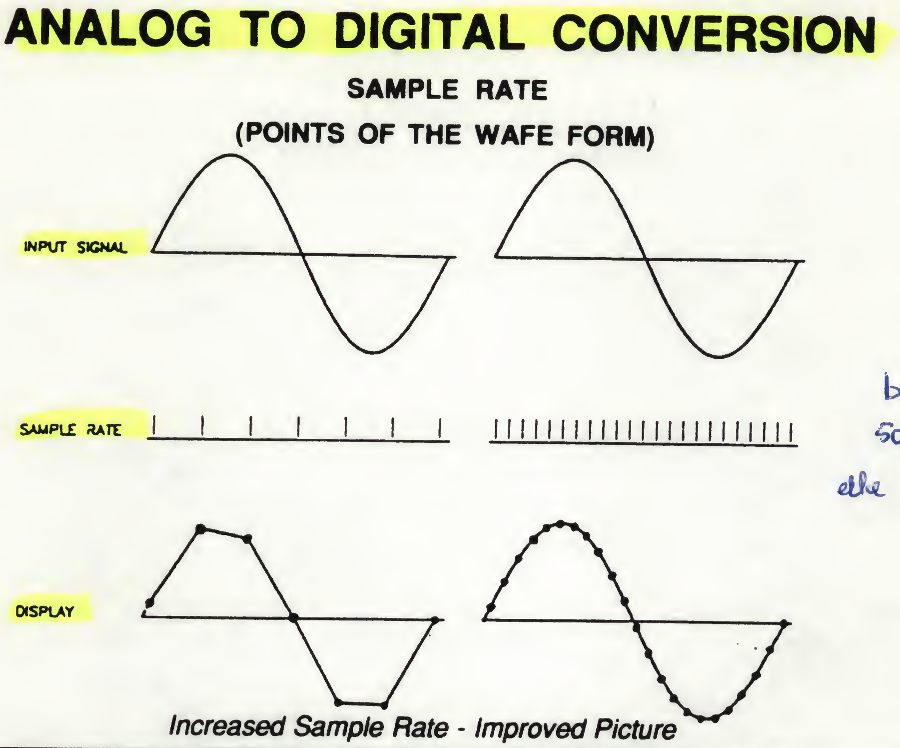
Summarising (Fig. 1-5)

The basic elements of digital storage oscilloscopes are:

- Analog-to-digital conversion
- Acquisition memory
- Storage and display
- Digital-to-analog conversion
- Timing control

Of these sections, the A-D CONVERSION is the most critical in determining the overall performance of a DSO.

ANALOG to DIGITAL Conversion



bv. 500 MS/s → elke 2 nsec sample

Figure 1-6

bediening TIME/div → sample rate wordt geregeld.

1.4 ANALOG-TO-DIGITAL CONVERSION

The A-D conversion process determines two of the DSOs major specifications:
the sample rate and vertical resolution.

1.4.1 Sample Rate (Fig. 1-6)

The sample rate determines the maximum frequency of the input waveform which can be sampled and reconstructed.

For good resolution of single-shot events the clock frequency should be between four and ten times the signal speed, depending on waveshape. For instance, to look at a transient in some detail, ten samples may be needed. However, checking the presence of a repetitive signal, say a sine-wave, will probably only require four samples per waveform.

To summarise, if a DSO has a sample rate of 100 MS/s (megasamples per second), then the acquisition bandwidth is about 25 MHz for repetitive or known signals, and 10 MHz for transients. Bandwidths lower than this will not show the waveform in enough detail.

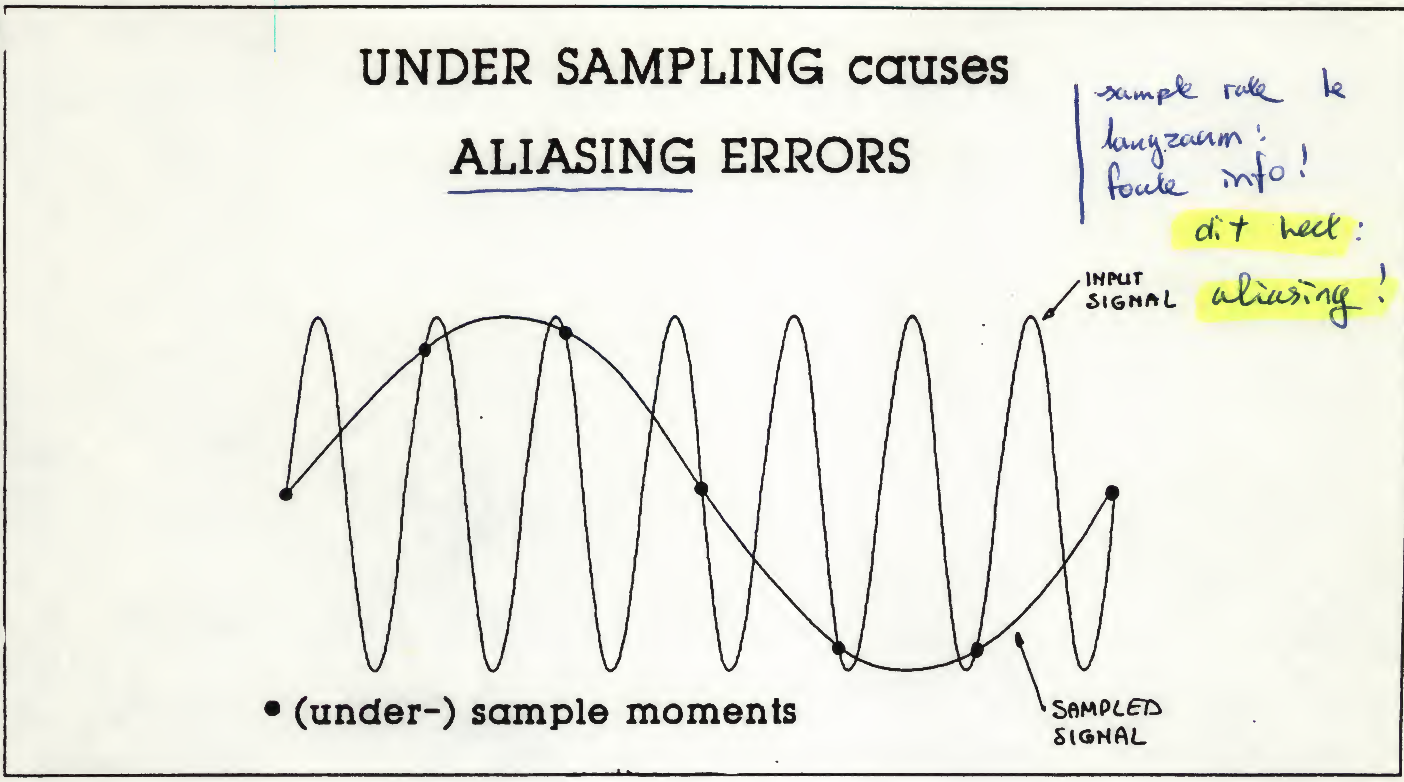


Figure 1-7

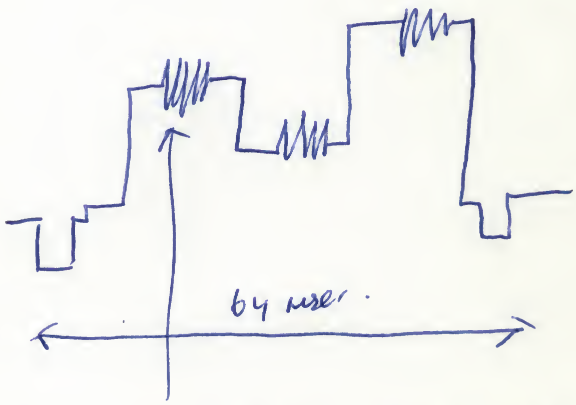
geval als:
i/p 1 MHz
samplerate 10 kHz/sec

1.4.2 Undersampling and Aliasing Errors (Fig. 1-7)

There is one more danger of sampling at too low a frequency - it can introduce **aliasing errors**. Aliasing is caused by using a sample rate that is below the Nyquist rate (less than twice the input frequency). This typically happens if there are large harmonic components in the incoming analog waveform. The display can then show a stable display at several timebase speeds, corresponding to the different harmonics.

Aliasing effects can be reduced by incorporating anti-aliasing filters into the DSO, and switching them in at each timebase speed to eliminate input frequencies higher than twice the sample frequency at that particular setting. However, such filters tend to be expensive, and will also attenuate important high-frequency transients. It is usually better for the DSO just to incorporate a high-frequency detector with a visual warning indicator.

To avoid aliasing errors, the rule-of-thumb is to start sampling at a higher sample rate or timebase speed and work down.



deze info wordt niet goed binnengehaald. opletten dus.

DEMO and HANDS-ON

1) DOTS
   - 2010 Hz signal input
   - autoset
   - dots on
   - (X) magnifier

2) ALIASING
   - autoset
   - Time Base control DOWN
   - (adjust freq)
   - Questions
     - Stable display ?
     - Triggering OK ?
     - How to detect ALIASING ?

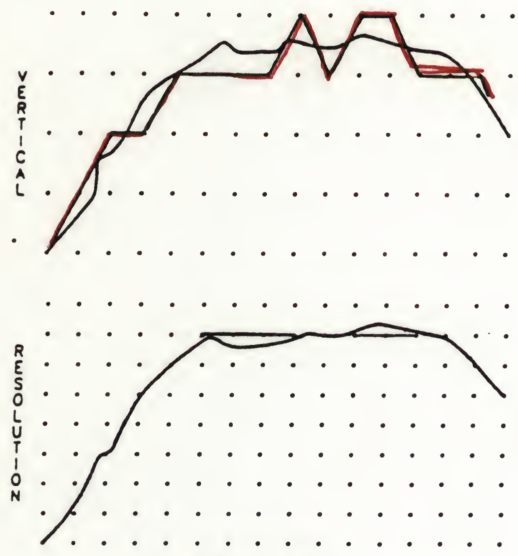
→ let op triggerpunt voorzijde → verschuift !

als signaal in min/max mode band wordt,
is signaal gealiased.
Dit is 100% betrouwbaar!

min/max mode   mode processing → kies min/max

VERTICAL RESOLUTION

(DIGITIZING THE VALUES)



lower resolution gives false indication of the original signal

higher resolution is nearer to the original signal detail

Figure 1-8

1.4.3 Vertical Resolution (Fig. 1-8)

The vertical resolution determines the detail that can be displayed; for example, showing whether the input waveform is a pure sine-wave, or whether any distortion is visible. The vertical resolution also determines the vertical *accuracy* of the samples waveform. Generally, the higher the vertical resolution, the greater the detail shown.

8 bits → 256 levels
12 bits → 1024 levels → grote scope's.

VERTICAL RESOLUTION
(DIGITIZING THE VALUES)

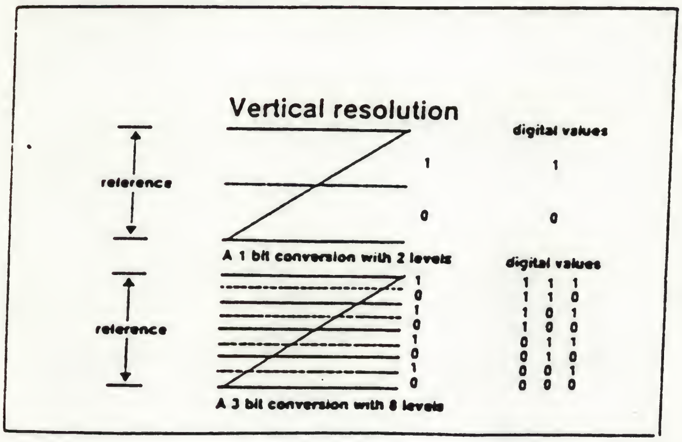


Figure 1-9

In Fig. 1-9, we look a little closer at the vertical resolution.

The a-d conversion process compares an incoming analog signal against the full-scale value of a reference voltage, and takes a number of decisions to determine which digital value best fits the analog signal.

An incoming analog signal could be compared with, say, a 2-volt reference. At the simplest level, the circuit could generate a 0 if the signal were between 0 and 1 V, and a 1 if the signal were between 1 V and 2 V. This single-bit digital word would thus describe the analog signal level. If we took a two-bit digital word, then 0 to 0.5 V would generate 00, 0.5 V to 1 V would generate 01, 1 V to 1.5 V would generate 10, and 1.5 V to 2 V would generate 11. The levels for a three-bit digital word are shown in Fig. 1-9.

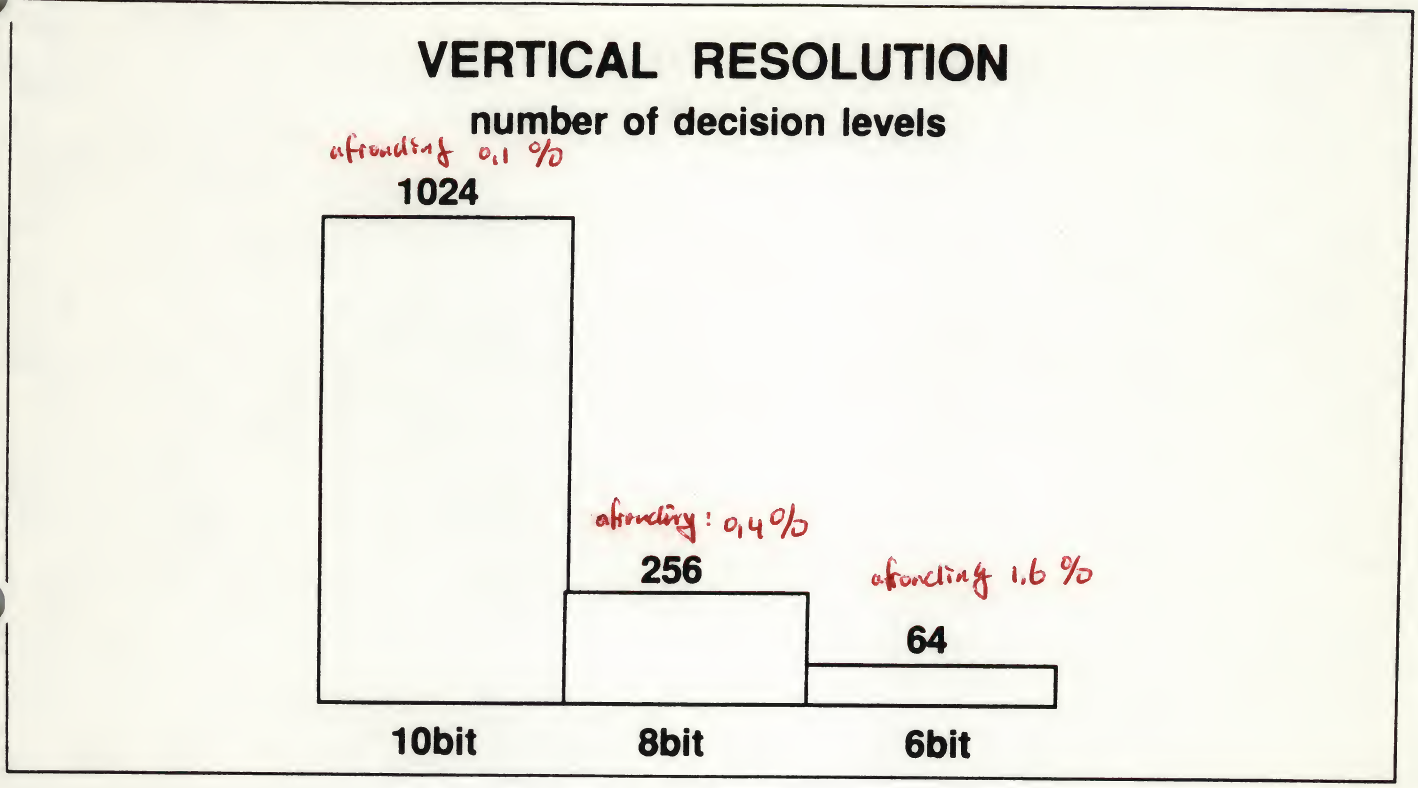


Figure 1-10

The number of decision levels for 6. 8 and 10 bit-words is shown in Fig. 1-10.
Each successive bit in the digital output word thus effectively records the result (0 or 1) of successively dividing the reference signal by two. The word length here determines the 'scope's **vertical resolution** - the number of possible levels to which it can resolve an input signal.

A single bit, expressed as 2^1, or two to the power one, can have one of two levels. Three bits have 2^3, or eight levels, and so on. In digital systems, a common word-length is eight bits (often referred to as a byte).
For an eight-bit a-d converter, the digital value can be one of 2^8 possible levels, or 256.

Each extra bit in the word length doubles the number of decision levels, and hence doubles the resolution: eight bits gives four times the resolution of six bits, and ten bits gives four times the resolution of eight bits.

ANALOG TO DIGITAL CONVERSION

SAMPLE RATE :

Determines maximum frequency of input waveform that can be reconstructed with good visibility of components

VERTICAL RESOLUTION :

Determines the value of waveshape information and the accuracy of vertical measurement and reconstruction

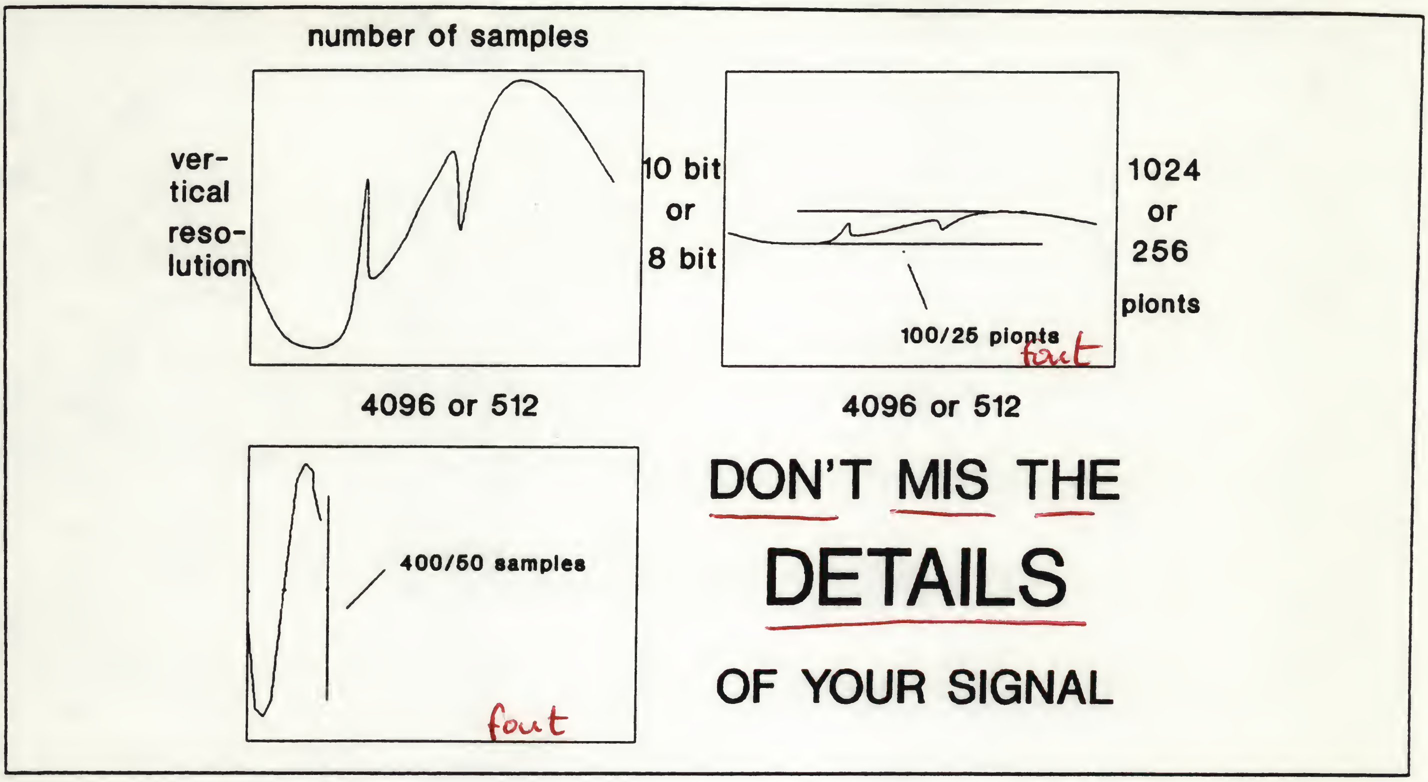
Figure 1-11

1.4.4 Summary (Fig. 1-11)

We have seen that the a-d converter is critical in determining the overall specifications of a DSO. Also that the two most important parameters are its word length and bandwidth.

The word length determines the 'scope's vertical resolution; for the PM 3320A this is 10 bits which, with a sensitivity down to 5 mV/division, gives the bit sensitivity of 50 uV which we calculated before.

The bandwidth of the a-d converter determines the maximum frequency of waveform which the 'scope can study. A 250-MS/s sample rate for example allows the PM 3320A to study 62.5 MHz signals, and 25 MHz transients.


number of samples
ver-
tical
reso-
lution
10 bit
or
8 bit
1024
or
256
plonts
100/25 plonts
fout
4096 or 512
4096 or 512
400/50 samples
fout
DON'T MIS THE
DETAILS
OF YOUR SIGNAL

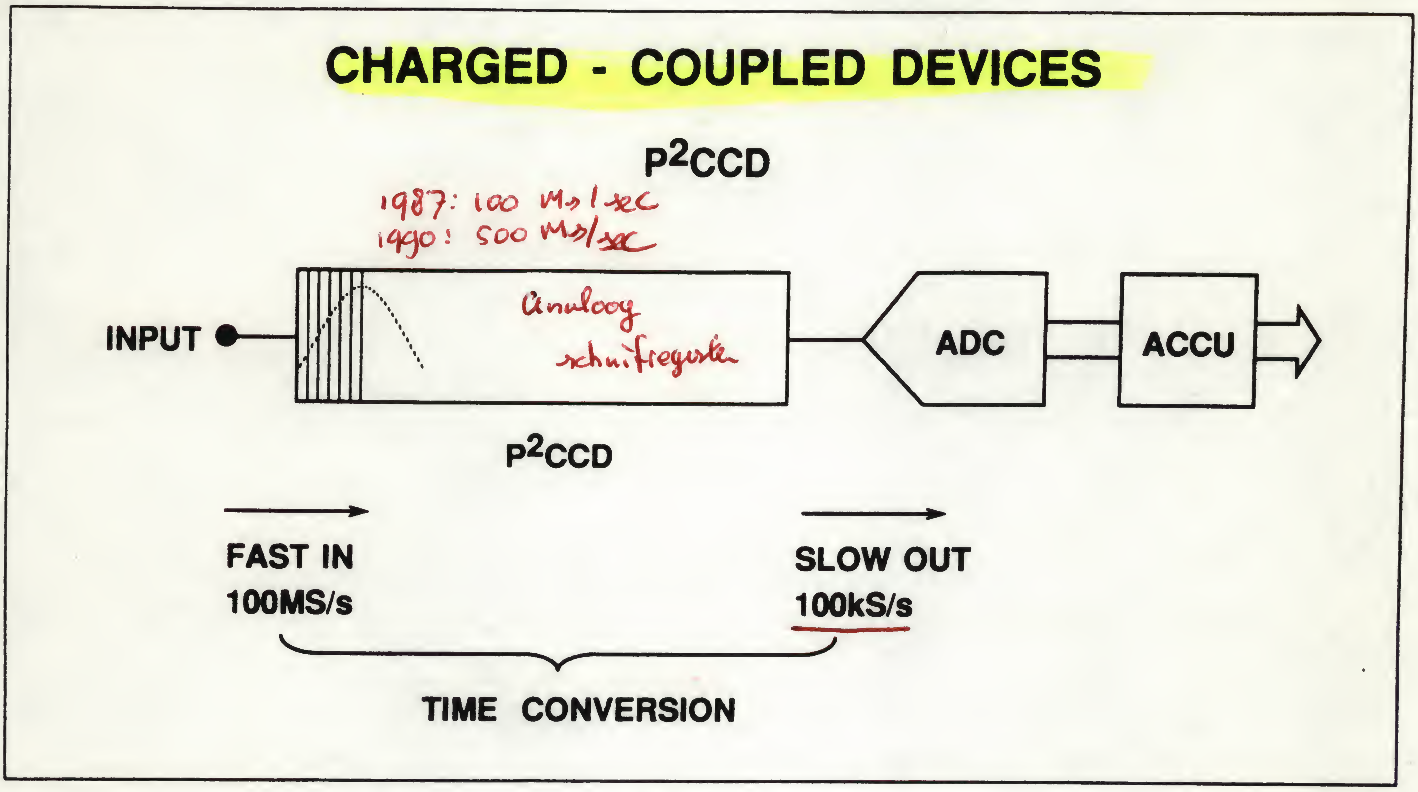


Figure 1-16

als snelheid extreem hoog wordt, wordt analoog geheugen toegepast dat signaal snel inleest en langzaam doorgeeft.

1.5.4 Charged-coupled Devices (Fig. 1-16)

The restrictions of the previous devices are largely overcome by the second major type of a-d conversion and sampling method used in DSOs - the charged-coupled device, or CCD.

A CCD consists of a number of cells that transfer charge from one to the next sequentially. You can think of a CCD as being an analog shift register, or a form of analog first-in, first-out device. In effect, a CCD consists of a *chain of sample-and-hold gates transferring their charge* from one to the other, with the charge thus rippling through the individual cells.

Time-conversion

A CCD can sample the input waveform very quickly until all the cells are full; the charge in each cell (representing the waveform's voltage at that time)can then be read out slowly and converted to digital form, giving a fast-in, slow-out capability. Thus, only the CCD itself needs to operate at the high sample rate, with the subsequent a-d conversion being made by slower devices, which will be less expensive or can have higher resolution. It also means that the acquisition memory can use standard components, again at less expense.

CHARGED - COUPLED DEVICES

ZERO-COMPENSATION

aantal elementen gelimiteerd → max 512

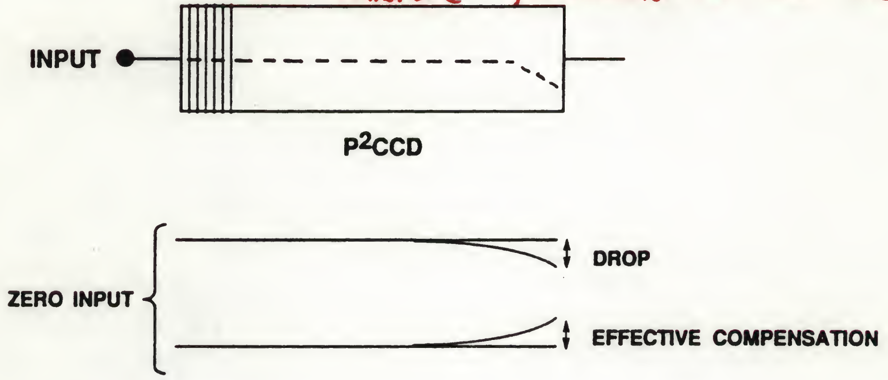


Figure 1-17

Zero-compensation (Fig. 1-17)

Consequently, a CCD gives high performance - 250 MS/s or more - at a much lower cost than an equivalent flash a-d converter. However, the number of cells in the CCD determines the length of the acquisition memory, and CCDs are generally limited in length to between 0.5 k and 1 k. The reason for this is simple. As the charge, which represents the analog voltage being measured, is transferred from one cell to another, the signal is degraded by leakage and noise.
This can be demonstrated by running an analog zero through the device.
The output has an offset, called droop, which reduces the accuracy of the sampled voltage, and hence limits the length of the CCD.
To compensate for the droop error, we can in fact run a zero voltage through the CCD, and add the inverse of the resulting output voltage to the signal output itself; i.e. mirror the droop.

DEMO and HANDS-ON

DIRECT sampling versus P2CCD sampling

4096 per slag

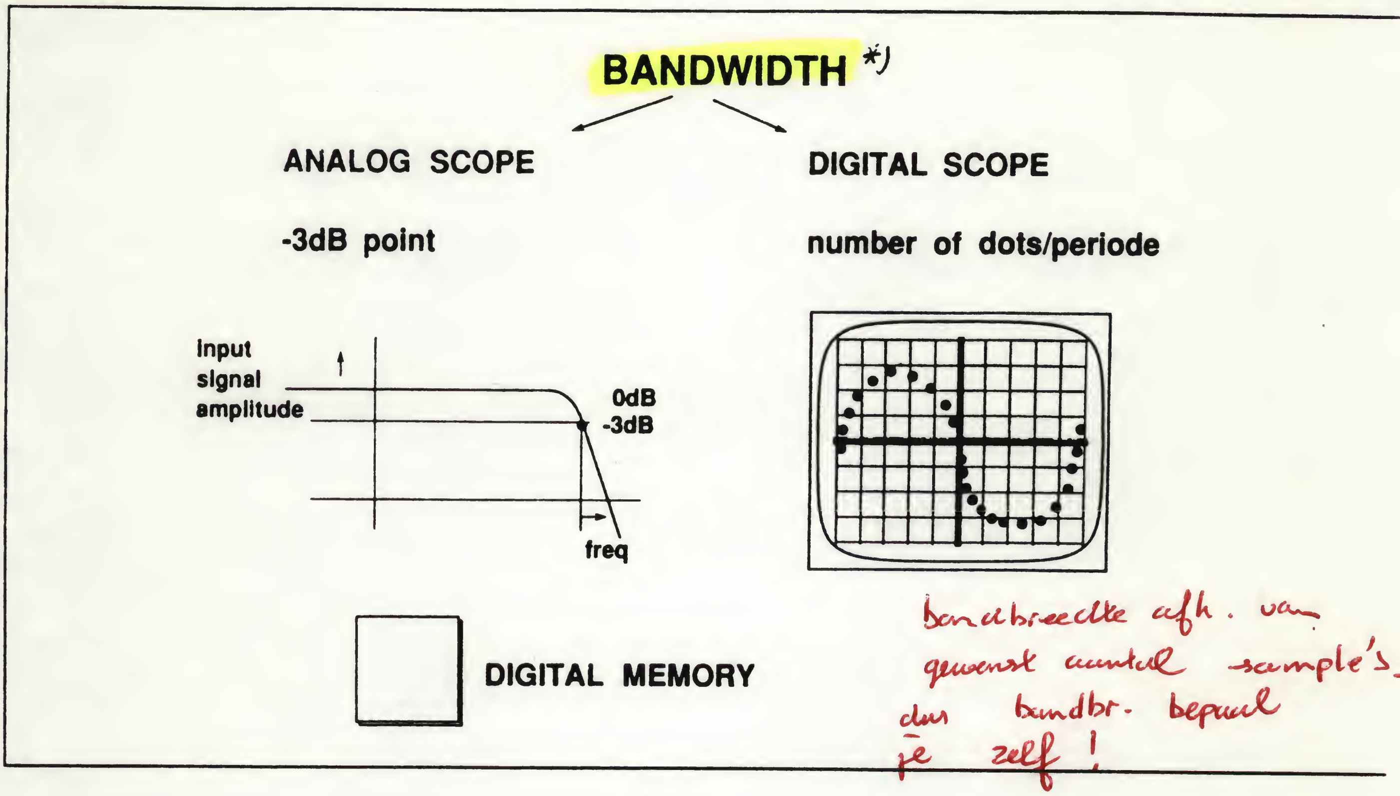
PM3350A..*3375*

- sine wave 400 Hz
- autoset
- TB : 5 msec
- dots on
- X magn : 1/32
- TB 1 step UP,→DOWN

infolengte 512 per slag

PM3320A/23

- sine wave 400 Hz
- autoset
- TB : 1 msec → P2CCD in actie
- dots on
- magnifier : 1/64
- TB 1 step UP/DOWN



bandbreedte afh. van gewenst aantal sample's dus bandbr. bepaal je zelf !

Figure

BANDWIDTH in the Analog and Digital modes *)

The bandwidth of the 'Analog' mode of the PM3350 can be examined by feeding a sinewave signal to the vertical input and tune the frequency upwards to the -3dB point (about 50MHz).

In a digital memory 'scope the bandwidth limit is reached when the number of samples over a period is not enough to define the shape of the waveform. As in a previous chapter described this number lies between 4 and 10. So 100 Mega samples/sec means 10 to 25 MHz bandwidth.

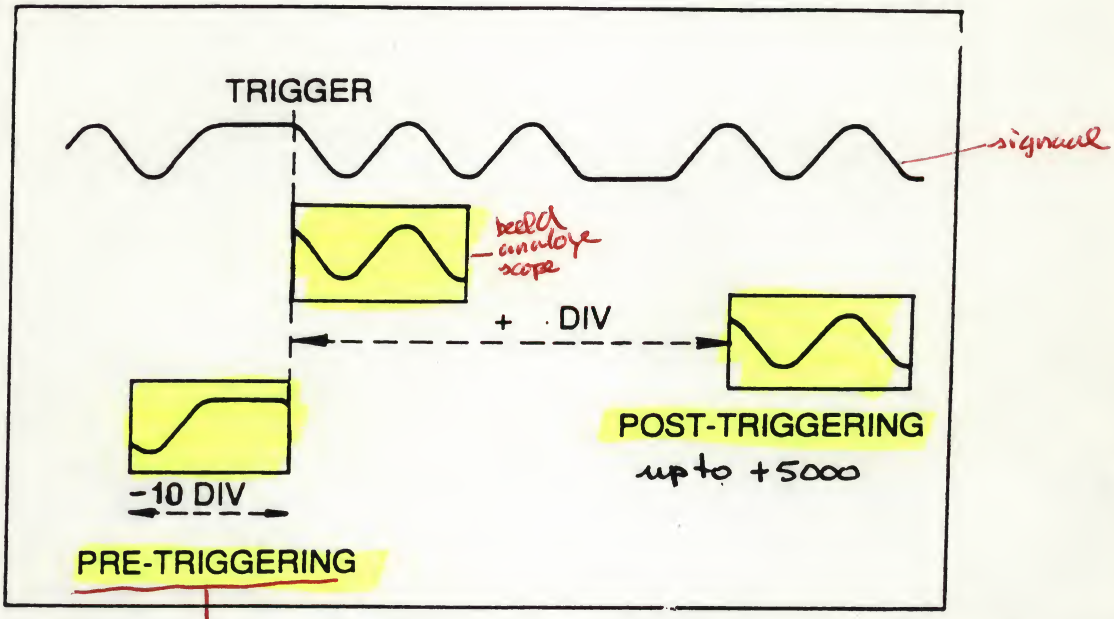
*) SINGLE SHOT Bandwidth!

PRE / POST TRIGGER

Delay

far away from the triggerpiont

POST AND PRE TRIGGERING



inhalen info wordt gestopt. info voor triggerpunt zichtbaar.

Figure 1-19

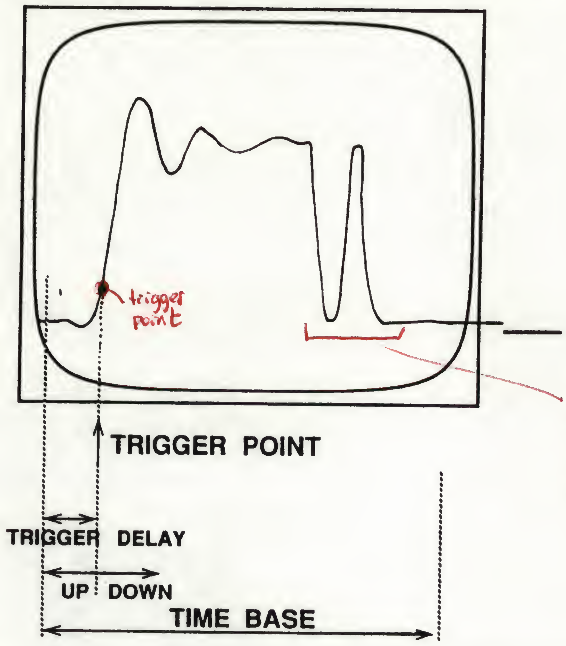
1 scherm = 1 geheugen info.

1.6 PRE- AND POST-TRIGGERING

Another technique that effectively increases the memory size of a DSO is **post-triggering**.

Unlike analog oscilloscopes, which are limited to triggering and displaying one screen of the waveform, a DSO can delay its acquisition after the trigger point by many screens - up to 5000 for some DSOs. This means that any part of the wavetrain can be selected and studied without the need for large memories.
Another powerful acquisition capability of the DSO, almost impossible with an analog 'scope, is in displaying **pre-trigger** information. This is in fact particularly simple with a DSO since the input waveform is continuously recorded ; this recording is stopped as soon as the trigger is received,

ACQUISITION CONTROL



R0 DISPLAY

dit deel eruit lichten: trigger point naar links, dan beeld uitrekken.

ZERO IN ON A SPECIFIC PART OF THE SIGNAL

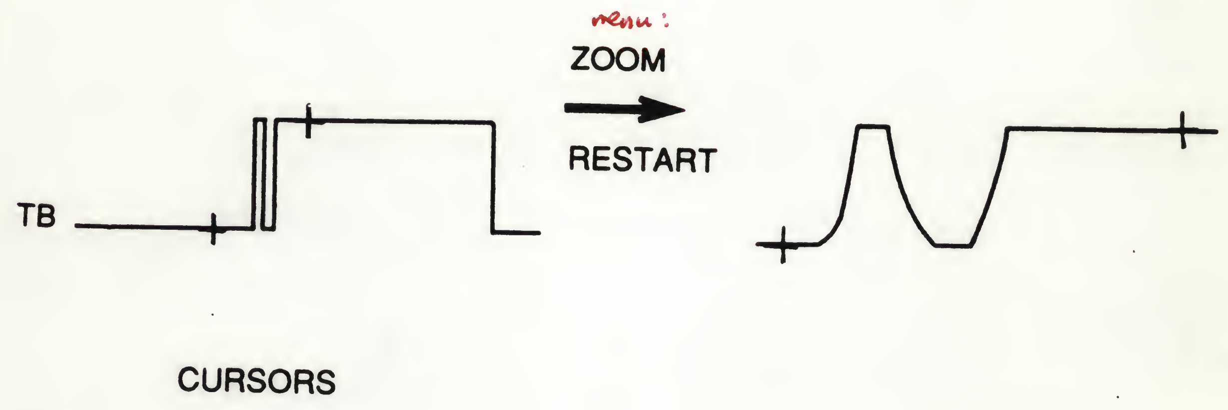
magnify → aantal details blijft gelijk!!

To take a closer look at signal details without losing the full resolution, a proper trigger point and trigger delay together with an appropriate time-base setting has to be chosen.

The left-hand side of the picture on the C.R.T. will be defined by the trigger source, -level and -slope and -coupling together with the trigger delay. The time-base speed defines the time window of the picture on the C.R.T.

Control of both the time-base and the trigger delay can be made MANUAL or AUTOMATIC.

ZOOM INTO DETAILS



Figure

PM 3350 series.

ZOOM Into Details

Analog 'Scopes (Zoom)

The typical ZOOM facility of an analog 'scope such as the Philips PM 3070 is shown in Fig.

For analog 'scopes the normal way of enlarging the details of a displayed waveform is by using the second or delayed timebase (DTB). This timebase starts after a controlled delay time (DTM) after the start of the main timebase (MTB).

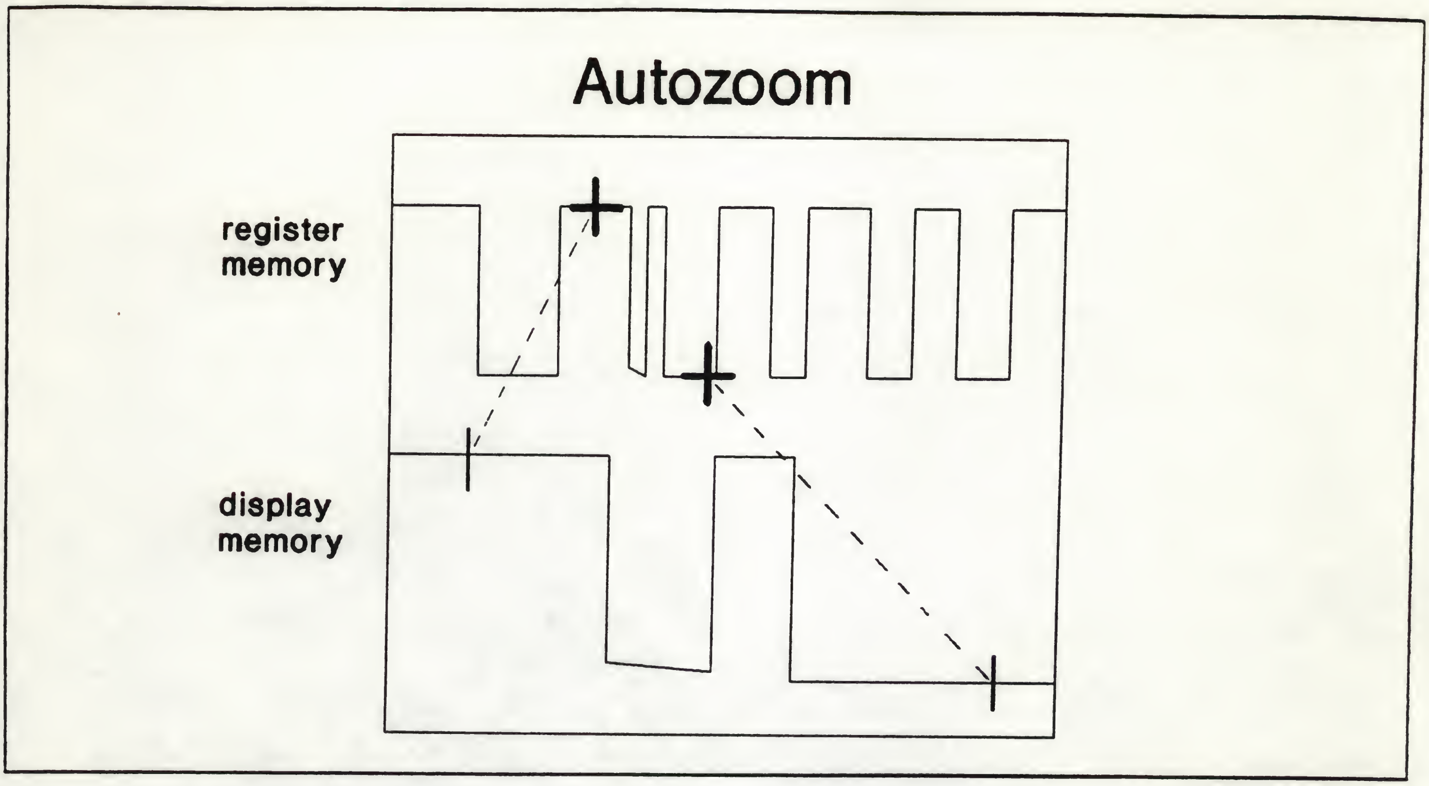
With CURSOR-ON and set around the required detail of the displayed waveform, the ZOOM function will calculate the new DTB and DTM settings to satisfy a delayed sweep of this detail.

Digital 'Scopes (Restart or Zoom)

In digital 'scopes such as the Philips PM 3350 (see Fig.), a detail of the signal can be located and extracted by the use of a trigger delay (in time, divisions or even after a count on external events) together with a faster acquisition (higher sample) rate.

This function is called **ZOOM** or **RESTART**.
It allows the user to zero in on a specific part of the signal, simply by positioning the cursors either side of the portion of waveform of interest and pressing the **RESTART** key.

The result is the re-acquisition of the signal part at *full resolution* (not just expansion which yields no further signal information), with a digital delay and timebase calculated from the position of the cursors. To complement the signal handling, there is a further signal expansion possibility



AUTO ZOOM PM3350A .. 3375

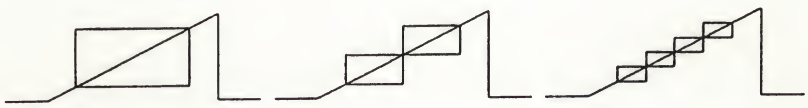
In this mode it is possible to simulate the operation of a delay time-base function by displaying a main time-base signal and a delayed time-base signal on the screen together.

The main time-base signal is stored in the REGISTER memory, simply load the signal to be examined into the REGISTER memory and display this on the screen. Move the live signal away from the stored signal by use of the channel position control.

When AUTO ZOOM is activated the MAIN CURSORS are set on the stored signal and the LOCATE CURSORS on the live signal. These cursors indicate the part of the signal that is displayed in more detail and can be shifted across the screen or the time-base can be expanded up or down by means of the softkeys. When the distance between the LOCATE CURSORS is less than 3 divisions or more than 9 divisions, then the time-base is automatically set to a more suitable setting. The result is that the live signal shows the adapted situation. This mode is not active if the signal memory is locked.

ACQUISITION CONTROL

Time base magnify and delay range



- Time base magnify uses a part of timebase sweep
- 1 ns/div ⟶ 20 ps/div
- Delay expressed in divisions is also magnified

PM3340 only

ZERO IN ON A SPECIFIC PART OF THE SIGNAL

To take a closer look at signal details without losing the full resolution, a proper trigger point and trigger delay together with an appropriate time-base setting has to be chosen.

The left-hand side of the picture on the C.R.T. will be defined by the trigger source, -level , -slope and -coupling together with the trigger delay. The time-base speed defines the time window of the picture on the C.R.T.

With the time base MAGNIFIER the displayed input signal can be 'expanded', relative to the CENTRE. In fact, this MAGNIFIER switches to a faster time-base, sets a new trigger delay and starts a new acquisition.

Note: First use the time-base control and the delay up/down softkeys to centre the interesting part of the input signal. Then use the time-base MAGNIFIER to focus on the details in that 'centre part' of the trace. Every step of the MAGNIFIER starts a new acquisition.

Note: The negative trigger delay for the PM3340 is limited to 9 nsec, which limits the range of the pre-triggering.

TRIGGERING

TO SET UP ...

mode TB TRIG MODE -› [AUTO], TRIG, SINGLE, MULTI
source TRIG SOURCE -›[A], B, EXT-AC, LINE
coupling TRIG COUPL -›[PP], DC, TVF, TVL , LF, HF
slope /, \
dc-level TRIG LEVEL -› rotary control (DC-level !)
LEVEL VIEUW

AND ...

channel coupling -›[AC], DC, GND

trigger delay TRIG DEL

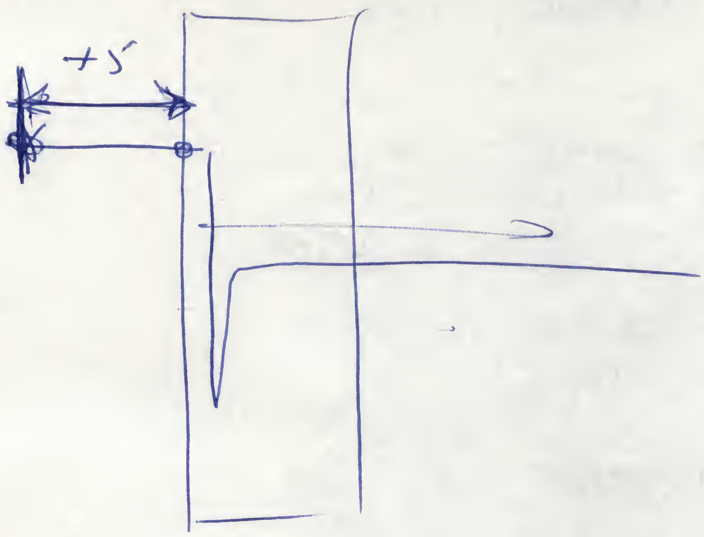
magnifier X-MAG (up to 1/64)
DISPL PART

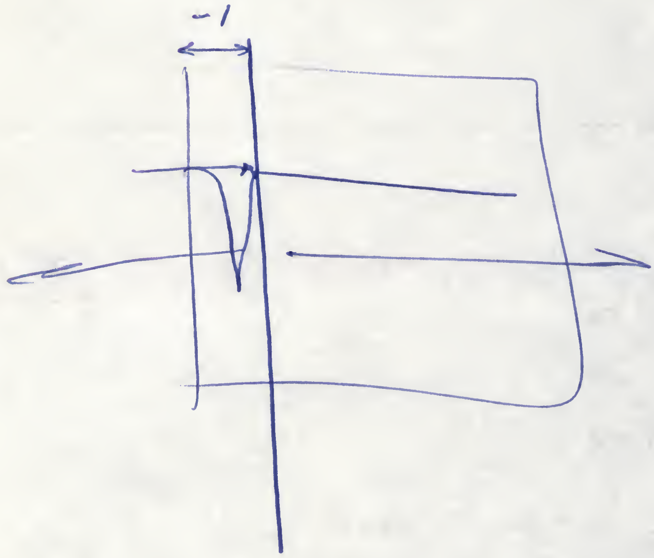
TRIGGER VIEW

When the 'trigger coupling' is set to DC , a trigger level set with the knob 'trig level', can be viewed on the display and set to a satisfied level. The trigger level is referred to the centre line of the display, as ground level (zero).
The trigger level view is active in both ANALOG and DIGITAL mode of the PM3350 series

Examine the trigger level control by triggering on an ramp signal. Adjust this signal to the centre of the display as ground.

PP triggering: midden tussen piekwaarden signaal.

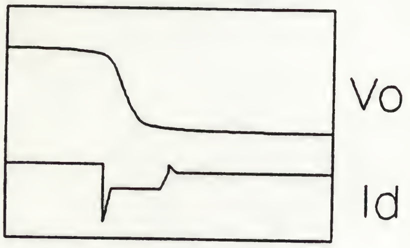

+5


-1

DEMO / HANDS-ON

Set up the TRIGGER by MANUAL selection of the items

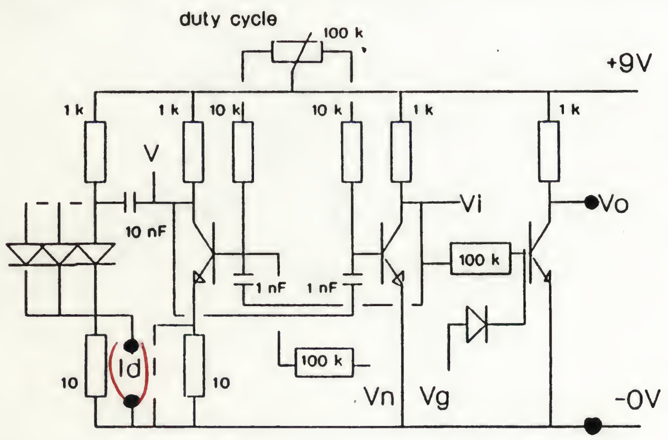
ZOOM into the details of a signal with
- manual control of the TRIGGER DELAY and Time Base
- CENTER / RESTART / REVERSE mode
- AUTO ZOOM mode



Use the Chopper Target

Zoom into the edge of the output square wave 'Vo' or the NEG current-peak 'Id'

CHOPPER TARGET

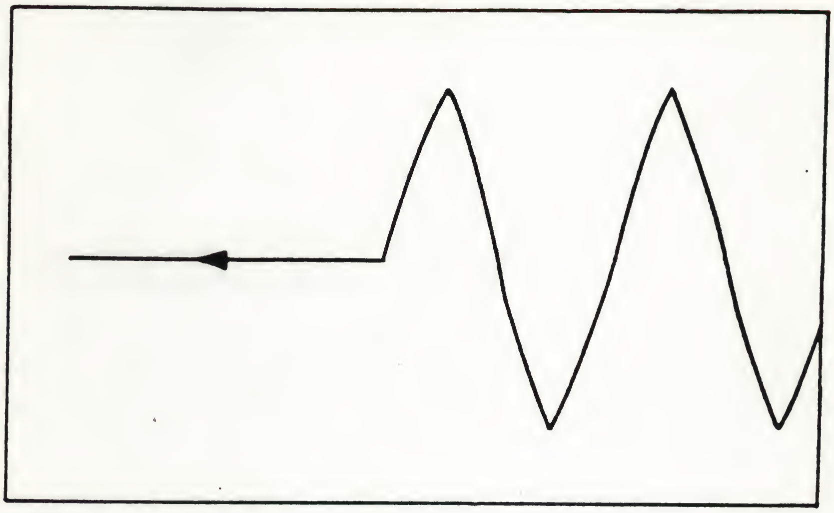


ROLL MODE

Watch-dog on slow moving signals

ROLL MODE

acquisitie wordt opgebouwd als papierrecorder.



scrolling from RIGHT to LEFT

Figure

Elke sample wordt direkt gedisplayed. Signaal wordt rechts ingeschoven.

TIMEBASE MODES

We have read how the information that can be shown by a digital storage oscilloscope depends on three major specifications:

- the vertical resolution
- the memory depth
- the sample rate.

Linked to the sample rate is the timebase. As the timebase of a DSO is derived from a crystal oscillator, it is much more accurate than that of an analog oscilloscope. Moreover, it can also be divided down to capture very slow signals, such as the temperature response of chemical reactions.
In fact, a DSO can capture signals with periods of several hours using a timebase speed of up to 1 hour/division, thus effectively acting as a line recorder. An example of this is shown in Fig. . where the sine-wave has taken over two hours to trace.
Some manufacturers label this capability the **ROLL MODE**, since the waveform rolls continuously across the screen from right to left.

ROLL mode <_> RECURREND mode

recurrend mode :

DISPLAY after COMPLETING the acquisition

roll mode :

DISPLAY after acquiring every SINGLE sample

Figure

Recurrent Mode

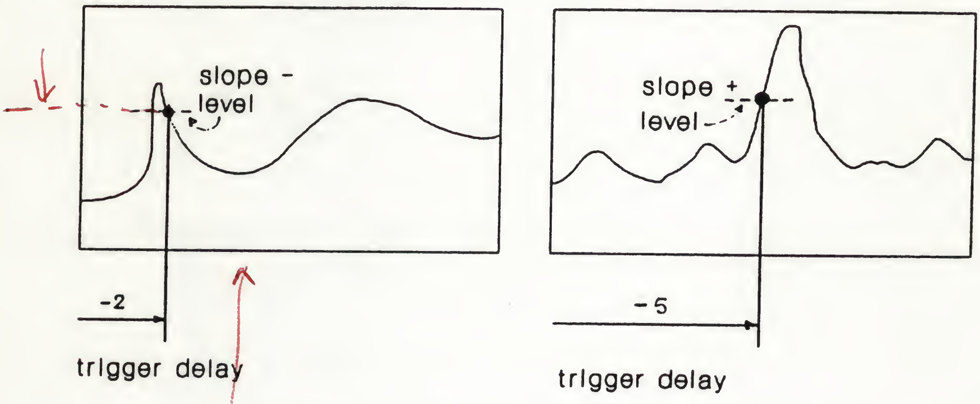
The recurrent mode is the normal timebase mode in which the contents of a register R0 are continuously refreshed on the receipt of new incoming trigger signals.
A comparison of the Roll mode and the Recurrent mode is shown in Fig.

Roll Mode

The continuous ROLL mode is typically used for very low-frequency signals and is effective with TIME/DIV settings at the low end. The signal is recorded in register R0 and is built-up point-by-point from the right-hand side of the CRT screen and continuously shifted towards the left after each sample.

DEMO / HANDS-ON

ROLL MODE with trigger stop



combine it with SINGLE or MULTIPLE mode

combine it with AUTO SINGLE PLOT mode

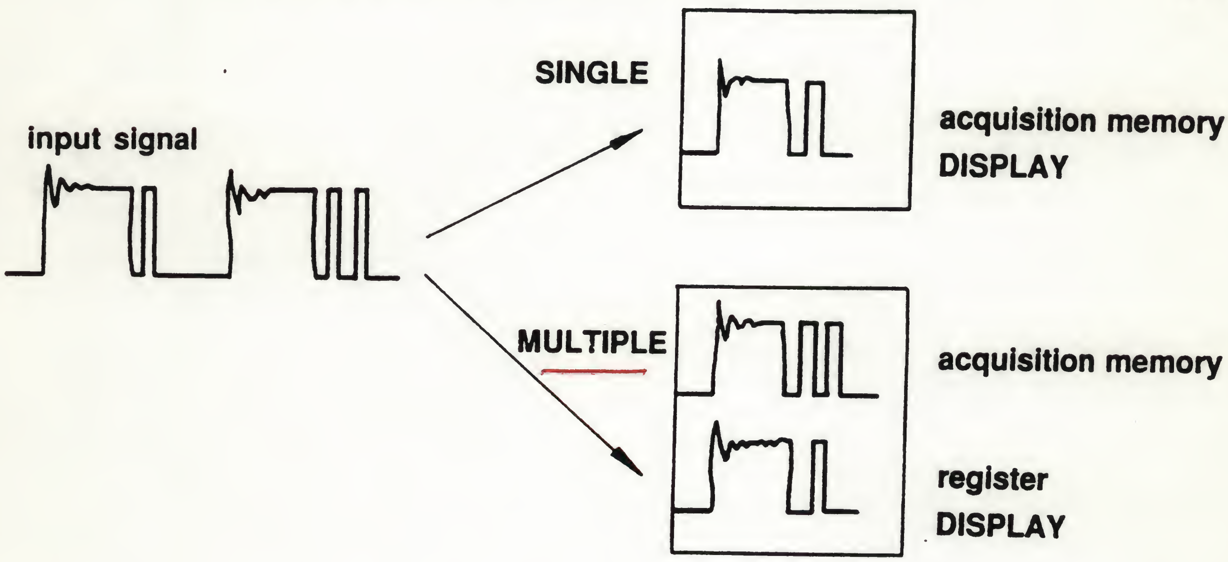
bij punt wordt getriggerd.
Beeld stopt 2 div. vanaf links.

SINGLE / MULTIPLE MODE

capture a single

kleine scope's
MF DSO
serie

SINGLE AND MULTIPLE MODE



Figure

multiple :

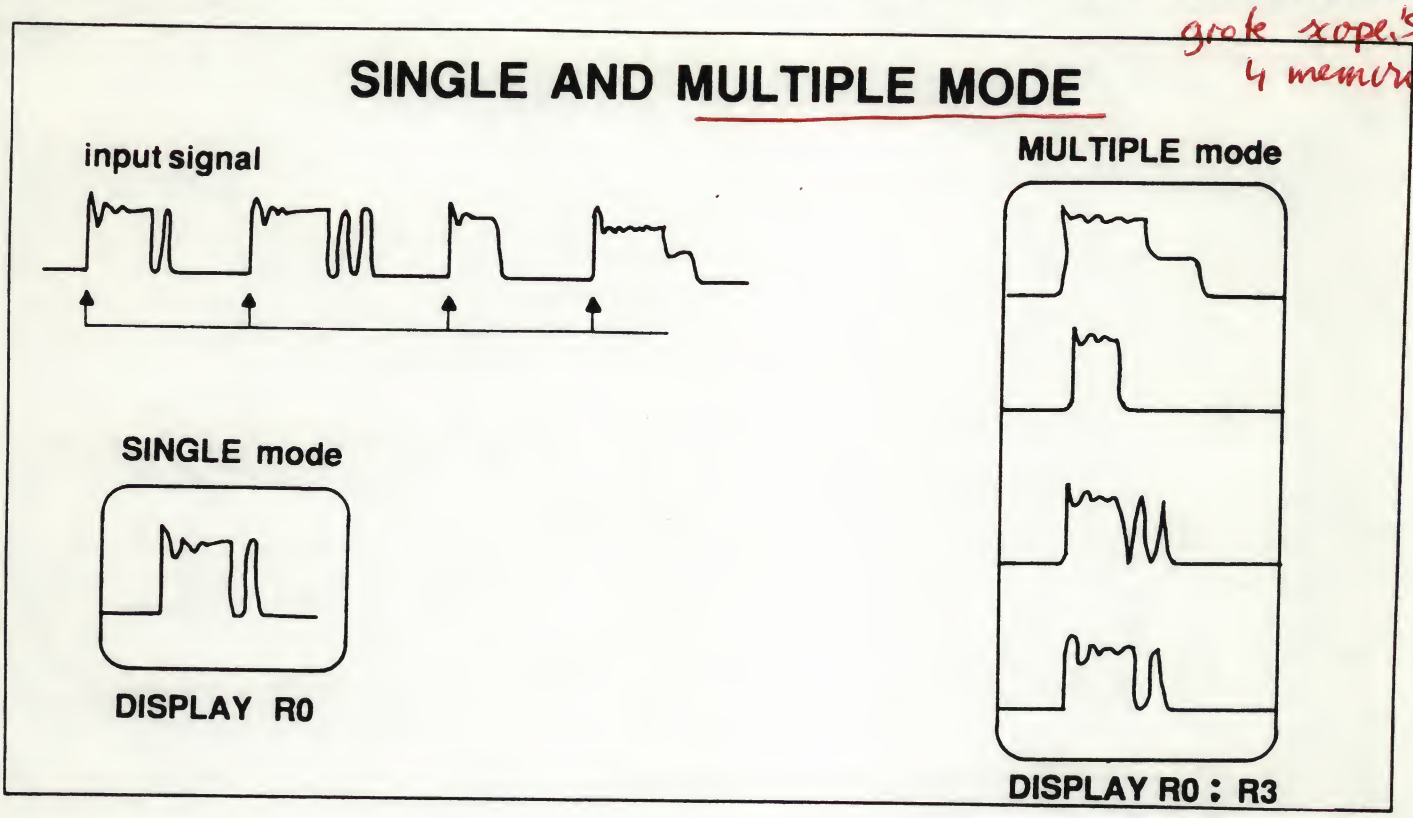
bij triggerpunt
wordt register geladen.
Bij 4 memories: 4X.
Triggerpunten kunnen ver
uit elkaar liggen!

Single and Multiple Modes

When the SINGLE mode is selected, the contents of the acquisition memory is refreshed once after a trigger pulse and the selected delay time; the refreshed contents is displayed on the CRT screen. As long as the instrument is waiting for a trigger pulse, the pilot lamp NOT TRG'D will light.

When the MULTIPLE mode is selected, the previously described SINGLE action is repeated two times. The result of the first SINGLE action is copied to the register, the second result stays in the acquisition memory. This copying procedure is done whether or not the registers are displayed.

grok scope's
4 memories

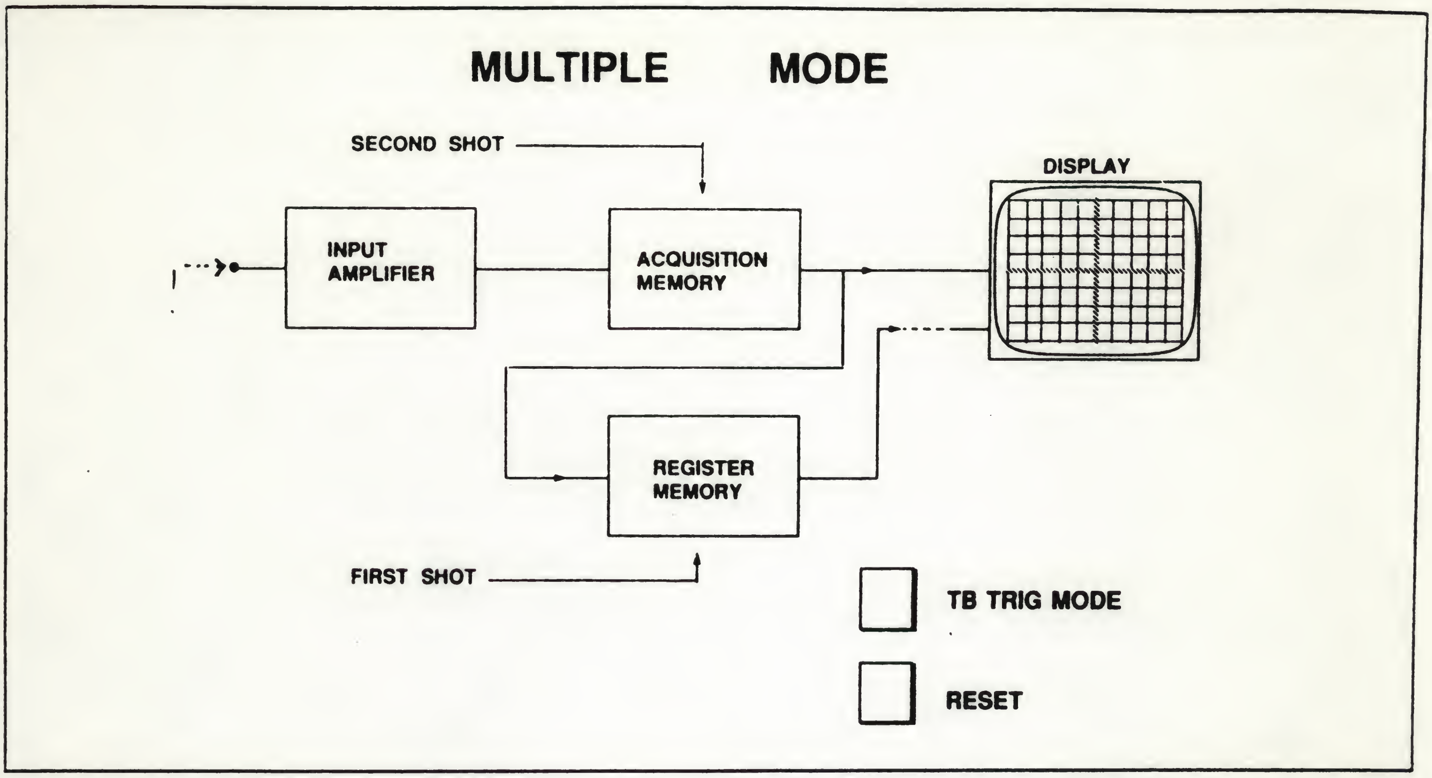


Figure

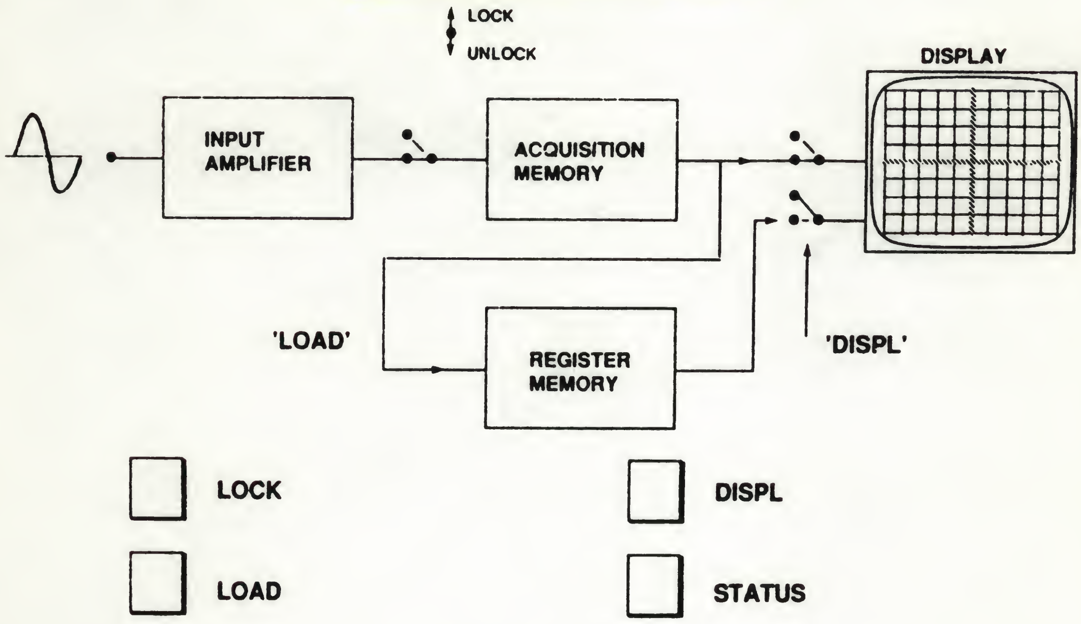
Single and Multiple Modes

When the SINGLE mode is selected, the contents of the acquisition memory is refreshed once after a trigger pulse and the selected delay time; the refreshed contents is displayed on the CRT screen. As long as the instrument is waiting for a trigger pulse, the (pilot lamp) NOT TRG'D will light.

When the MULTIPLE mode is selected, the previously described SINGLE action is repeated


MULTIPLE MODE
SECOND SHOT
DISPLAY
INPUT AMPLIFIER
ACQUISITION MEMORY
REGISTER MEMORY
FIRST SHOT
TB TRIG MODE
RESET

STORE FACILITIES



Figure

Van elk register kan de status aangevraagd worden.

Store facilities (digital mode)

Once a signal is captured in the acquisition memory, it can be copied to a 'REGISTER'('LOAD' button). The contents of this register can be displayed on the display together with the contents of the acquisition memory. Toggling the 'DISPL' button selects the memories to be displayed.

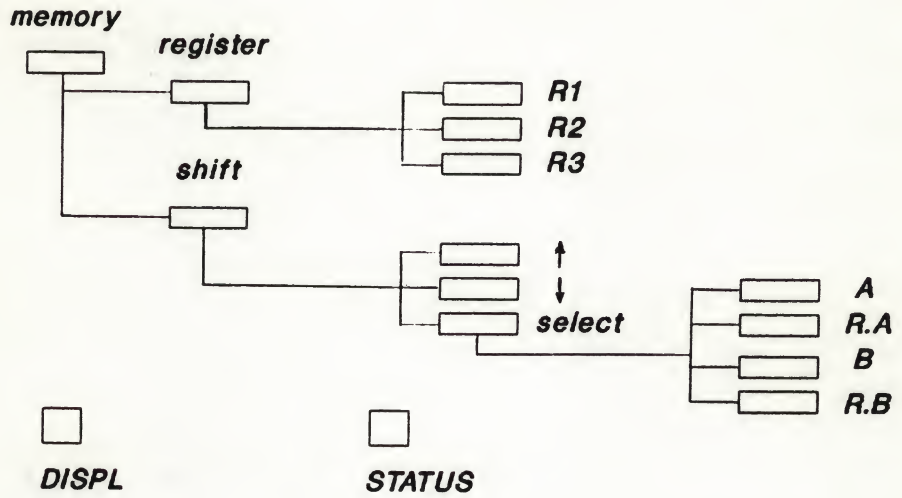
The register contents can be used f.i. as a reference to new measurements.

Examine the signals stored in the acquisition and the register memories and notice the settings of the register memory by pushing the 'status' button.

MEMORY menu

choice out of 3 REGISTERS

CREATE your own TRACE REFERENCES

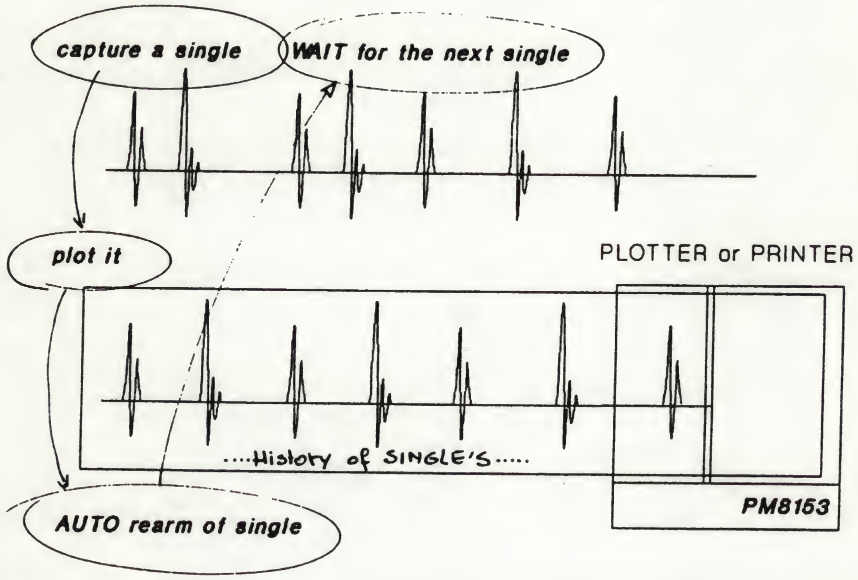


MEMORY menu   MF DSO serie (PM 3350...)

With the FRONTS menu it is possible to store up to 63 different settings of the front panel keys in the oscilloscope memory.
In the REGISTERS menu it is possible to choose between R1 or R2 or R3 for the active register memory, upon which operations can be performed.
The traces on the screen can be shifted with the SHIFT menu.

CAPTURE SINGLE events and PLOT them

set a PROPPER tigger piont



Auto Plot of Singles also in ROLL mode?

Make your own HISTORY of SINGLE events !

als plotmode op auto →
elke single wordt geplot.
Daarna wordt register gerearmen
en kan volgende single
worden ingelezen.

PM 8155

Expanded Buffer for Improved Efficiency

With a full 32k Byke input buffer, the PM 8155 ensures user-efficiency by being able to accept a large volume of input data. This frees the source instrument (oscilloscope, etc.) or computer from which it is plotting to move on to the next task while the plotter is at work.

Convenient Auto-Sheet Feeder

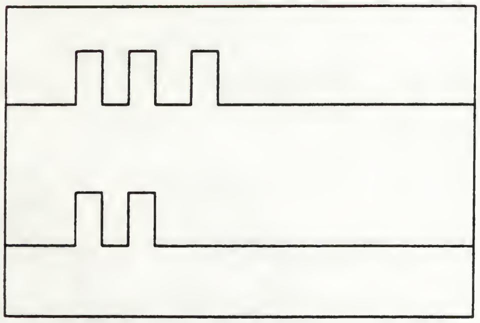
Efficiency of use is further enhanced by the optional sheet feeder. Accommodating 8-1/2 x 11 inch (alternately ISO A4) sized sheets, the feeder includes a paper cassette and an output stacking tray. Both can easily be added to the plotter with no need for adjustment or modification, making the PM 8155 ideal for unattended production of large series of multiple plots.

Added Fluke & Philips Compatibility

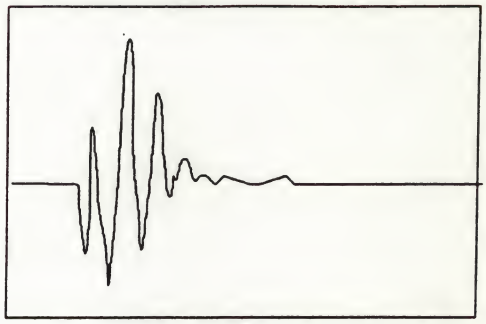
The PM 8155 is ideal as an output device for a variety of other Fluke and Philips instruments. Interface it directly to the PM 3350 or PM 3320A digital storage oscilloscopes, for example, with the need for a controller, to provide high resolution, hard copy documentation of both the signal and the scale factors displayed on the CRT. Add the Auto-Sheet feeder, and the DSO's Auto-Plot feature lets you document long series of single-shot events-unattended.

CAPTURE MULTIPLE and SINGLE events

set a PROPPER tigger piont



capture a TELEPHONE signal with MULTIPLE



capture a MICROPHONE signal with SINGLE

SINGLE shot voice capture

Connect a microphone to the input of the vertical input   Try to capture a 'voice' signal with the 'SINGLE' shot timebase mode using the digital 'MEMORY' mode of the 'scope. Set the proper trigger level, timebase and vertical sensitivity and START the measurement with the ~~'RESET'~~ button. CLEAR After capturing the "voice" signal, measure with the calculation softkey menu the frequency of this signal.

max res. → uit !

MULTIPLE mode

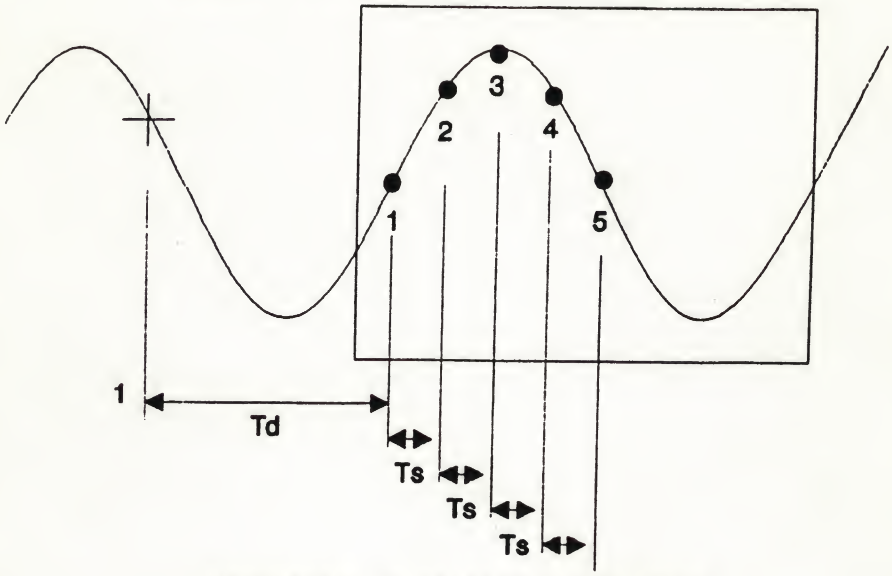
Prepare the 'scope for MULTIPLE shot   Connect a low frequent sine wave signal (1 Hz) to the vertical input. Start the Multiple shot acquisition with the 'RESET' button and change after about 8 seconds the waveform on the synthesizer to a squarewave. Wait until the total acquisition is done.

Examine the contents of the acquisition and register memory using the 'DISPL' button and shift the traces with the 'SHIFT' softkey menu.

1.2 SIGNAL ACQUISITION

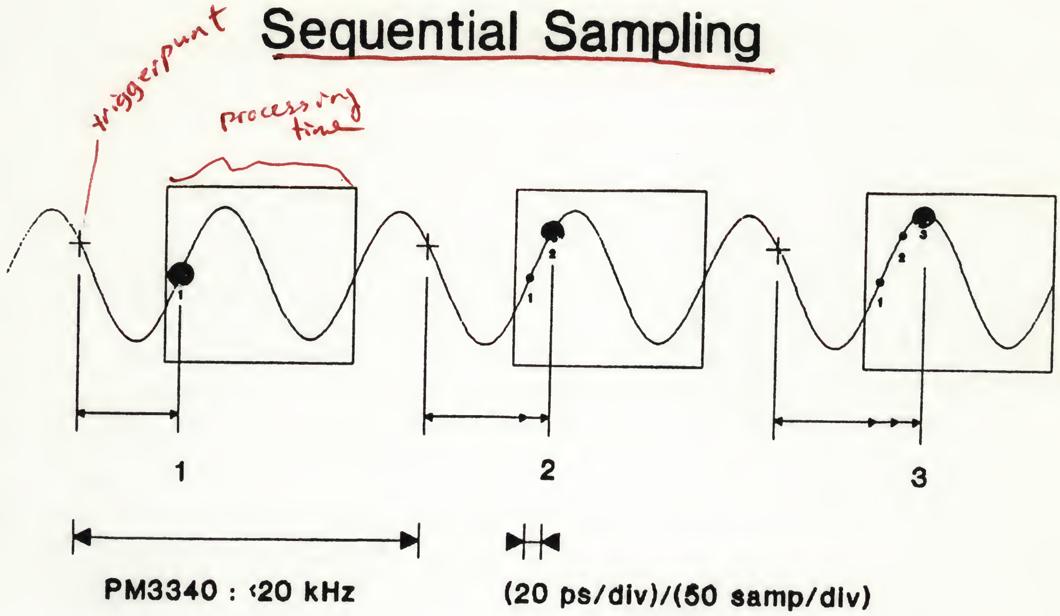
On the next page is given an overview of the different ways a DSO can acquire input signals.

Real Time Sampling



Samplerate : 4 ns/samp = 250 Ms/s

Sequential Sampling

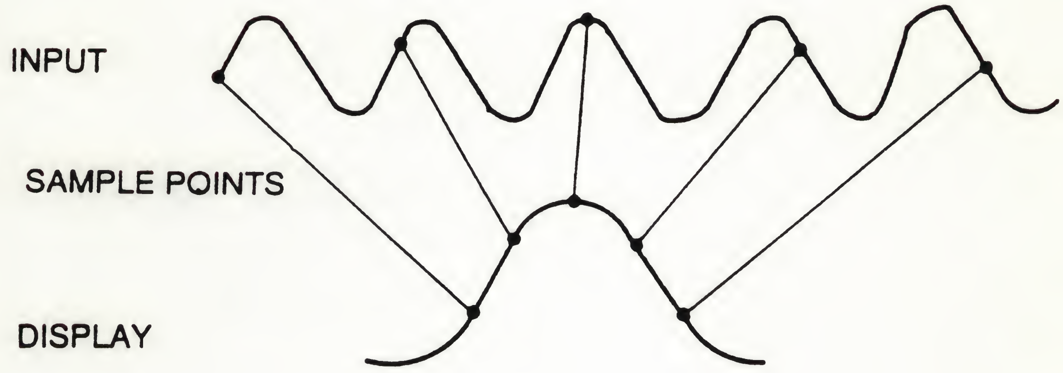


repatative sampling

signaal dient continue aanwezig te zijn en niet te veranderen !

SEQUENTIAL SAMPLING

(TIME CONVERTING SAMPLING)



Figure

2.2 SEQUENTIAL SAMPLING, TIME-CONVERTING SAMPLING

Although we have said that DSOs are primarily used for single-event capture, there is an added bonus - at the high end of the frequency spectrum a DSO can also acquire and store repetitive signals above its maximum sample rate.

There are two main methods of doing this: by **sequential sampling** or by **random sampling**. Sequential sampling is the most straightforward method.

2.2.1 Sequential Sampling

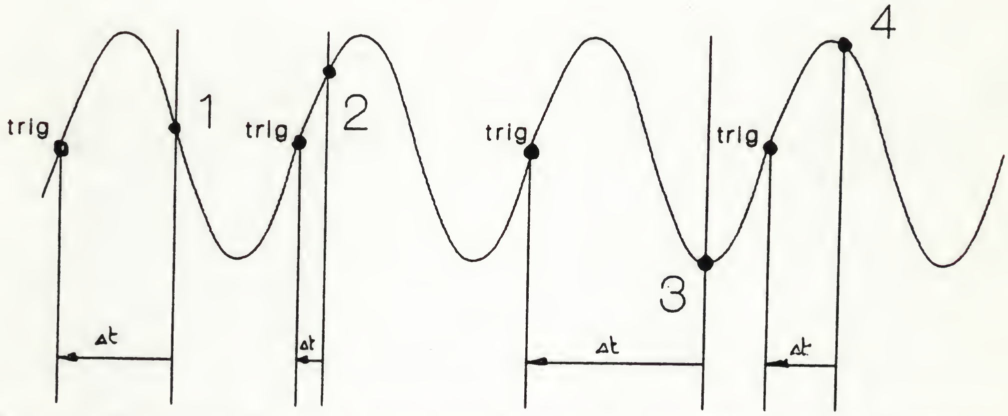
In sequential sampling, the waveform is built-up over a number of sweeps by delaying the sample point each sweep by a fixed time value t (delta t) from the trigger, thus sampling at T, T+t, T+2t, T+3t ... T+nt along the waveform.

Sequential sampling can therefore quickly build-up and display waveforms within a well-defined time. Sequential sampling, however, has its limitations. For example, it cannot be used to show the rising edge of widely-spaced pulses that are very short in duration, such as those produced by lasers. For displaying such pre-trigger information, random sampling is needed.

sequential timing:
niet in staat
negative triggering
te gebruiken !! (techn. basis)
wel met random
sampling.

RAMDOM SAMPLING

PM 3320A



Take a Sample . Take a Sample . Take a Sample . Take a Sample

<u>and measure the time to the trigger piont</u>

<u>random sampling:</u>

- kan langer duren voordat aquisitie rond is en plaatje stabiel is.
- negatieve triggerdelay is mogelijk,

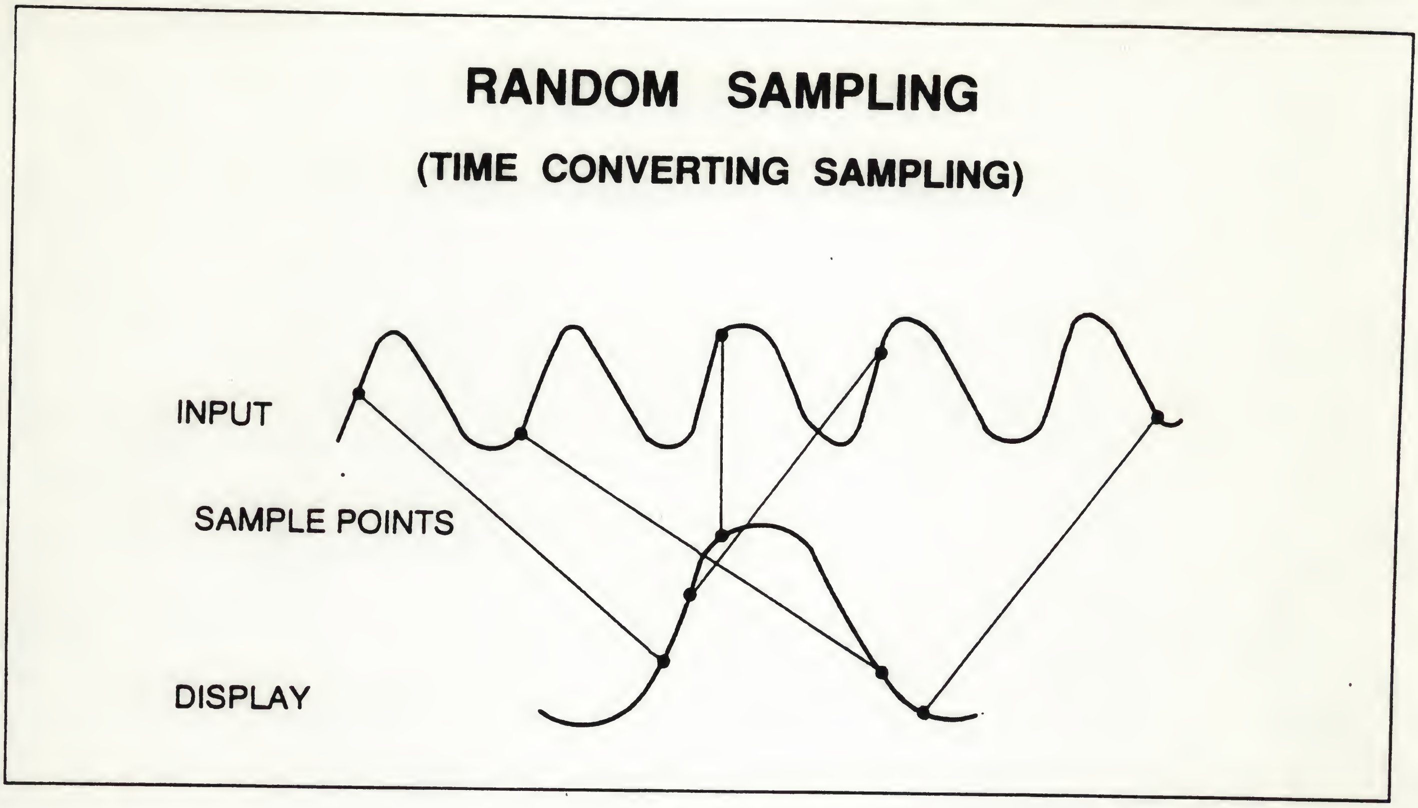


Figure 2-6

2.2.2 Random Sampling (Fig. 2-6)

In random sampling, the waveform is still built-up over a number of sweeps, but the sample is taken on random cycles of the oscilloscope's clock. There is therefore no fixed relationship between the sample and the trigger point. Additional circuits measure the time between the trigger point and each individual sample, and thereby store the sample in the correct memory position.
Although this does give the ability to display pre-trigger information (shown on the diagram at the nth pass), random sampling cannot be used in all applications. To understand why, consider a 50 MS/s DSO sampling a 200 MHz waveform. It will take a sample every four cycles of the waveform, and should build-up the required ten samples in about 40 cycles. Normally, input signals suffer from slight variations in frequency, which cause the sample (which is actually stored on the rising edge of the DSO's clock) to be taken at different points in the waveform, which satisfies the requirement. However, if the input signal is extremely stable (e.g. from a synthesizer), then the samples might always be taken from the same point on the waveform. In theory, this might go on indefinitely; in practice it means that the acquisition time for random sampling is not as predictable as that for sequential sampling.

2.2.3 Sampling Summary

Digital storage oscilloscopes are becoming increasingly popular in R&D, production and service, and in fact anywhere a conventional analog oscilloscope is being used. The major difference is that the measuring power and capabilities of a DSO extend its use way beyond that of its analog counterpart.
Either of the two repetitive sampling methods can effectively increase the sample rate of the DSO into the GS/s range.
The DSO therefore has several advantages over an analog 'scope. Although it does not have the "infinite" resolution provided by an analog 'scope, its high-frequency performance is comparable, and it can capture much lower-frequency signals - even those lasting as long as 10 hours. It stores single-shot signals and transients for later study, either on-screen using cursors for immediate measurement, or by transferring the digital waveform to a remote computer.

single shot: alleen in realtime mode -

MF-DSO'S

```
                         ACQUISITION MODES
 ______________________________________________________________________

PM3350A   (PM3355)
PM3365A   (PM3375)
=================
timebase    |-----------------|------------------|-----------|
           50s               5ms            500(200)ns      20ns

MODE       <-------------REAL-TIME--------------><-SEQUENTIAL->
                    (recurrend mode)            |   PM3365A    |
acq.       <---direct-----><------P2CCD-------->    PM3375     |
           |               |<---low-res----->  |               |
           | straight on   | via analog        |               |
           |  in memory    |shift regist.      |               |
samples A  |    4096       |     512           |      512      |
      A+B  |   2x2048      |    2x512          |     2x512     |
           <-----single-shot-event------------->               |
           |               |                   |               |
Samples/sec               80KS/s         100(250)MS/s      2.5GS/s
                           |-------------------|               |
                           |<---repetitive---only---------->   |
                           |<---single-acquisition--------->   |
                             NO: PRE-TRIGGER Delay

PM3335 :
========
timebase   |-------------------------------------|
          50s                                  500ns

MODE       <-------------REAL-TIME-------------->
           |        (recurrend mode)             |
acq.       <----------------direct-------------->
           |                                     |
           | straight on in memory               |
           |  in memory                          |
samples A  |    4096 / 8192                      |
      A+B  |   2x2048 ....                       |
           <-----single-shot-event-------------->
           |               |                     |
Samples/sec                                    20MS/s
```

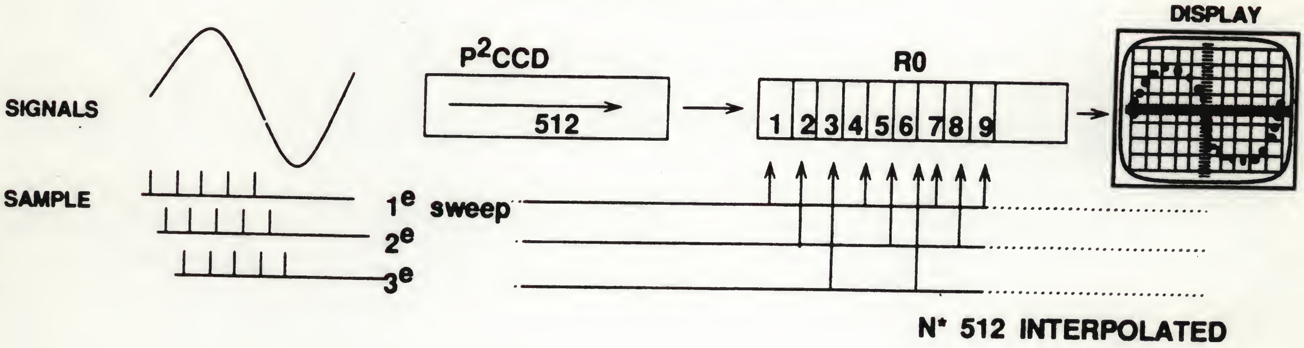
~~single event → puls die maar 1x voorkomt.~~

DIGITIZING

(TIME CONVERSION VIA P^2CCD)

MAX RESOLUTION

only PM 3320A/23



Figure

8x sweep 512 punten.
sweep steeds iets verschuiven.
→ 4k punten in geheugen.
(max. resolutie mode)

$\boxed{\text{8 sweeps nodig}}$

Maximum Resolution

The Time Conversion mode the iterpolated samples can be replaced by real samples if the input signal has a repetitive character. This is called **MAXIMUM RESOLUTION**, and if this mode is selected, the pilot lamp **REP ONLY** is on to warn that it needs repetive signals.
Samples are then taken over anumber of sweeps. During each sweep 512 samples are taken and placed in the register.

ACQUISITION

PM3320A /23 /40

ACQUISITION MODES

```
PM3320A (PM3323)
================
timebase       5s                   1ms(.)          200ns(100ns)     5ns

MODE           <——————————REAL-TIME——————————————><——RANDOM——>

acq.           <——direct————><————P2CCD————>
                              <——low-res————>
                straight on    via analog
                 in memory    shift regist.
samples A          4096 — max res   512
        A+B       2x2048           2x512
               <————single-shot-event—————>
                                                          10 GS/sec
Samples/sec                400KS             250MS(500MS)

samples A                   <——max--res——>
        A+B                     8x512            512
                              2x4x512           2x512
                            <———repetitive——only————>
                            <———single-acquisition———>

PM3340 :
========
timebase                          20us                          1ns/div
magnifier                                                         x50
sweep max                                                       20ps/div

MODE                             <—————————SEQUENTIAL————————>
samples                                      512/64
                                 <————————repetitive-only—————>
                                 <————————single-acquisition———>
```

1 kanaal : 4 k wordt gebruikt
2 kanalen : 2 k per kanaal .

CHAPTER 2

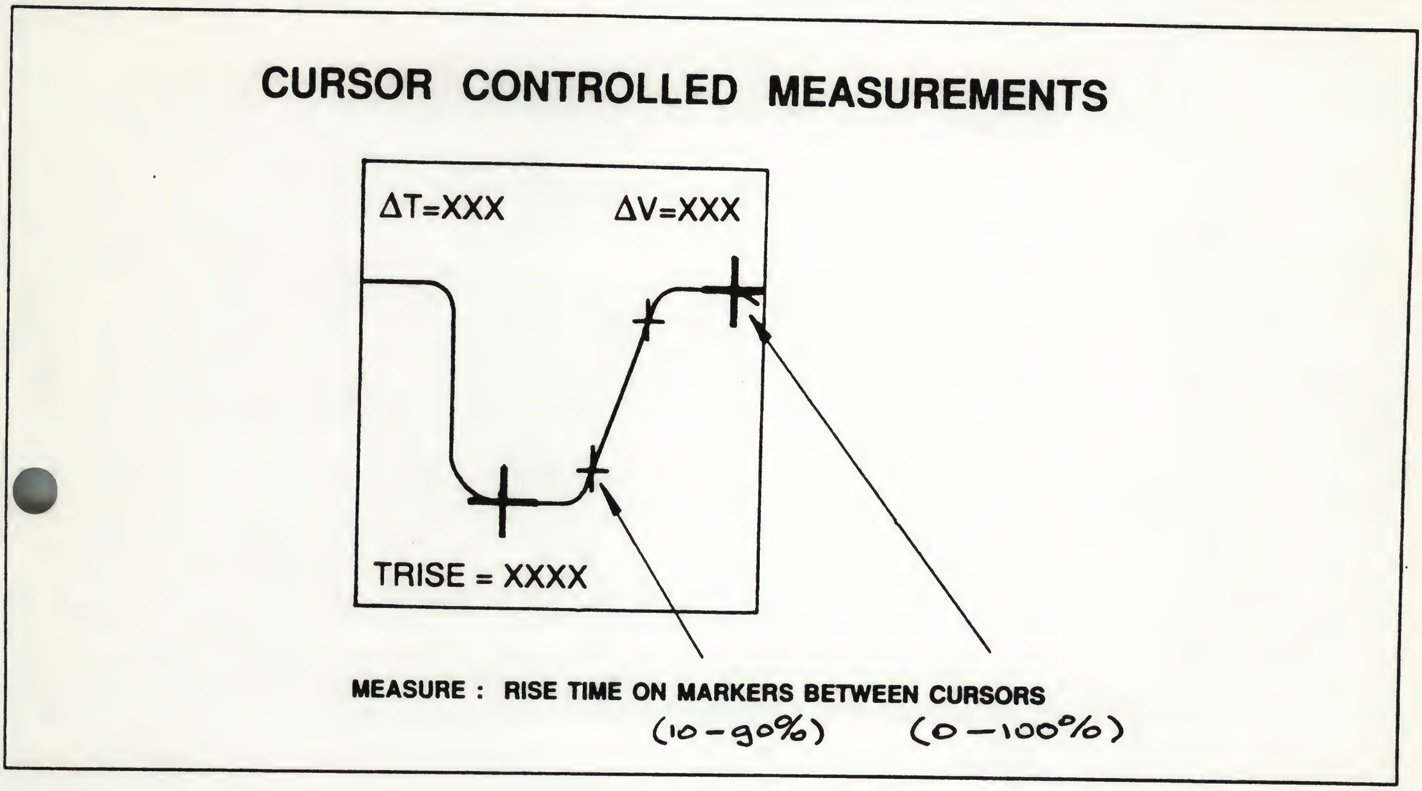
PROCESSING

PM3350_series

A useful reference to the HANDS-ON on the PM3350 will be the booklet:
BASIC PRINCIPLES OF DSO'S
Using the PM3350
no 9498 720 04615

CURSOR CONTROLED MEASUREMENTS

don't gamble, measure!

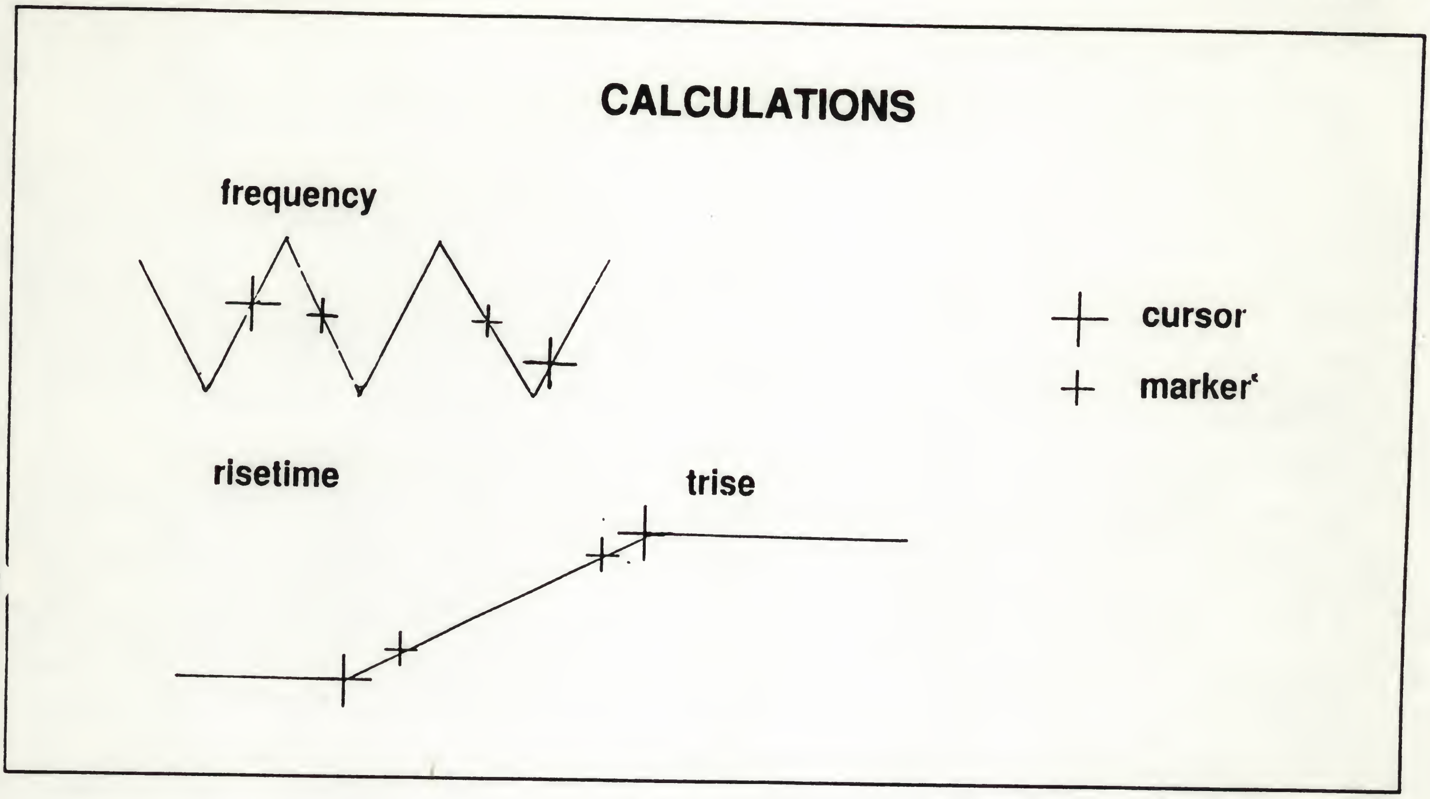


Figure

Cursor Measurements on Digital 'Scopes

In a digital storage oscilloscope, cursors are not merely electronic graticule lines displayed over the oscillogram on the screen, as with analog 'scopes. Instead, in a DSO, cursors represent display highlights of actual datapoints present in a memory. The numerical value of the delta-distance between cursors is therefore extremely accurate. Measurement accuracy of signal parameters is a function of the utilisation of available memory width (vertical bits used) and timebase speed.

Since DSOs usually have an abundance of microprocessor power on board, many **automatic calculations** may be available, providing direct readouts of **risetimes, mean values, RMS, frequencies, P-P values**, etc.



Figure

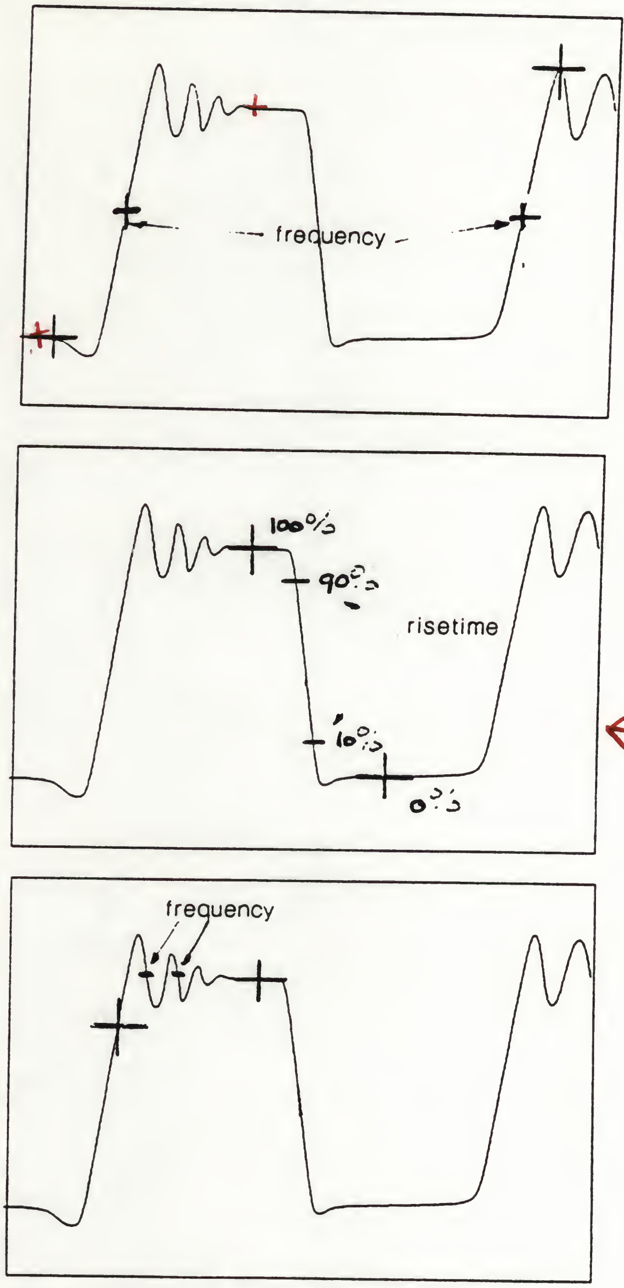
Calculations

Calculations like frequency, risetime and peak to peak voltage , on a selected trace , can be selected and controlled with the softkey menu. Be aware that the calculations are performed in the area enclosed by the cursors. So frequency cannot be measured when no complete period exist between the two cursors. Rise time is calculated with the cursors referencing to the 0% and 100% levels.

Markers referring to the points on the traces between the actual calculation is done.

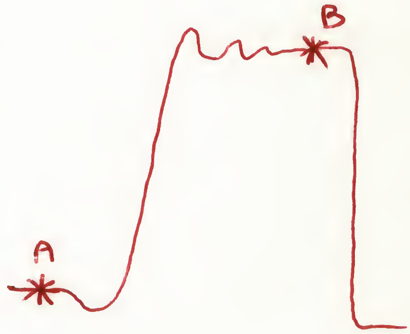
See Chapter 4.3.2 in the Operation Guide.

CURSOR CONTROLLED MEASUREMENTS



predifined measurements
in respect to the cursors position !

risetime



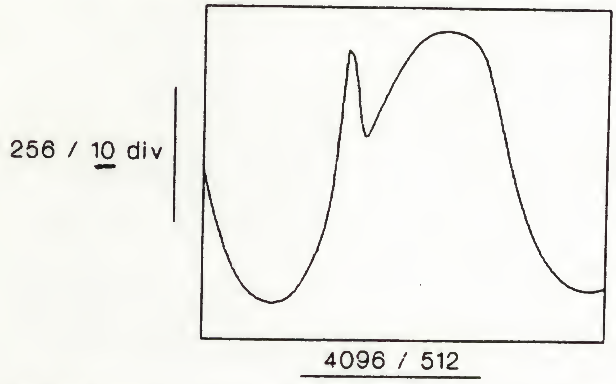
risetime: nodig 100% en 0% ref. points.

Instelling: A en B. markers ~~cursortjes~~ verschijnen bij 10 en 90%.

NOTE : Select first the calculation to be done. Then adjust the cursors to the right place on the traces to get the wanted measurement as indicated by the system with the markers.

ACCURACY

vertical / horizontal

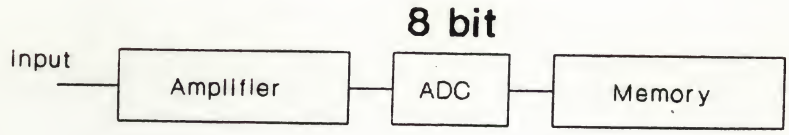


10 x 10 div

Voltage : Amplifier + ADC errors

Time : Sample speed + Memory errors

vertical

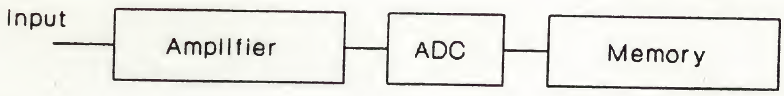


offset	8 bit ▪ 10 divisions
ampl. factor	peak 1 div ▪ 4 % errror
non linearity	peak 8 div ▪ .5 % error
+	
total 3 %	peak 10 div ▪ .4 % error
BOTTOM 3 % !!	*from .4 to 4 % !!*

(and NOISE)

horizontal

10.2 div



4096 / 512 pionts

error .025 / .2 %

acquisition error 0.1 %

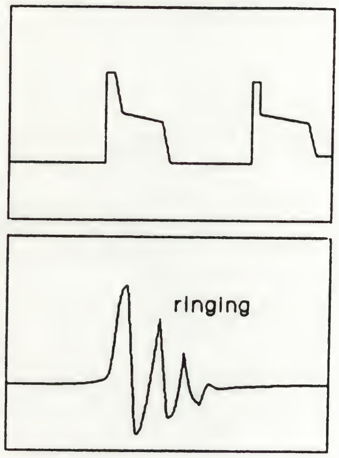
CURSOR measure error .1 % + res (min .025 /.2 %)

measure 5 div = .05 / .4 % error

DISPLAY error 1 %

DEMO / HANDS-ON

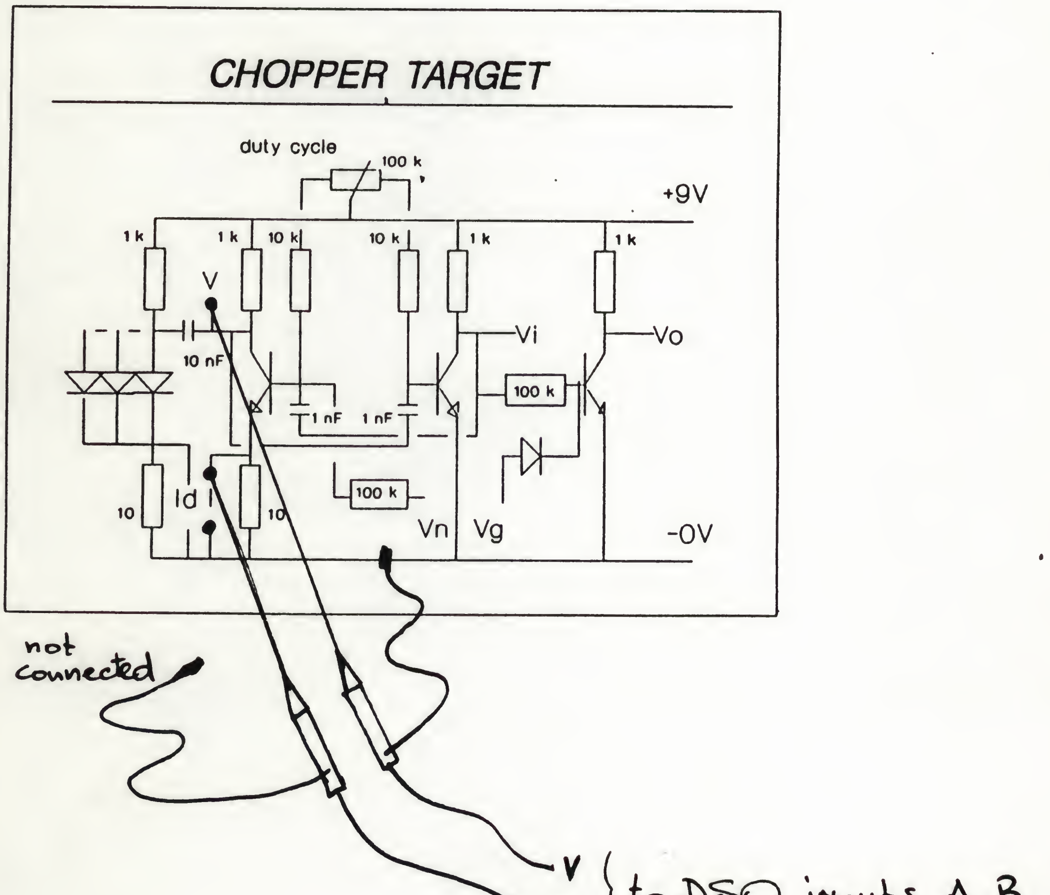
Measure the Vpp and FREQ of a square wave signal and it's RINGING on the edges



Use the Chopper Target

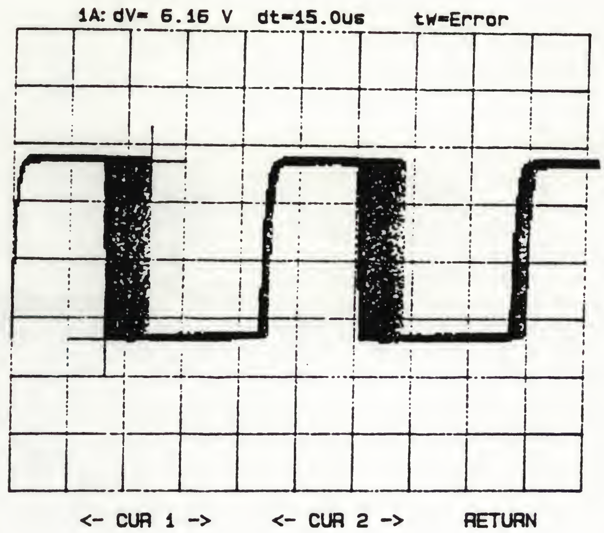
Zoom into the edge of the the POS current-peak 'I'

To create a RINGING make a BAD earth connection on the probe tip

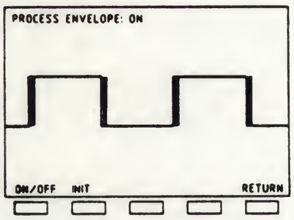


ENVELOPE MODE

jitter measurements



PROCESS ENVELOPE menu



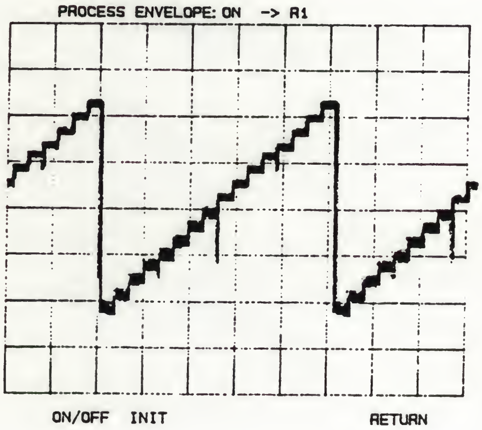
This function stores alternating the minimum and the maximum of each sample position over the sweeps taken. The ENVELOPE is stored in the reference register (R1, R2 or R3) and default displayed together with the acquired signal (display memory R0).

Once activated, this is a continuous process until it is switched-off. The ENVELOPE process is started again when the INIT softkey is pressed or when the triggering or amplitude control is changed. In this case the display memory is cleared.

Activating or re-activating of the ENVELOPE process can be done by using the ON/OFF softkey.

DEMO / HANDS-ON

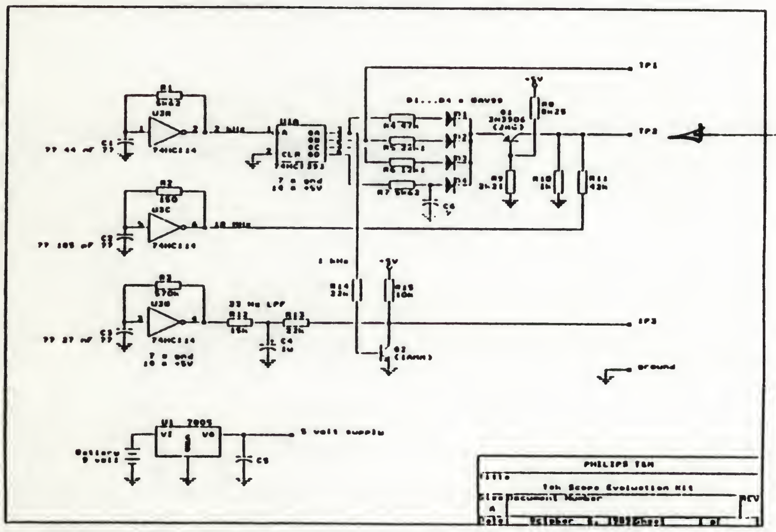
Measure from the sawtooth target the modulation amplitude and the location of the glitches



Use the Sawtooth Target

Zoom into the glitch areas to define the glitches

SAW TOOTH TARGET



TP2

DETECTION OF GLITCHES

1' know where to find the glitches

2'verify with the help of
the ENVELOPE mode

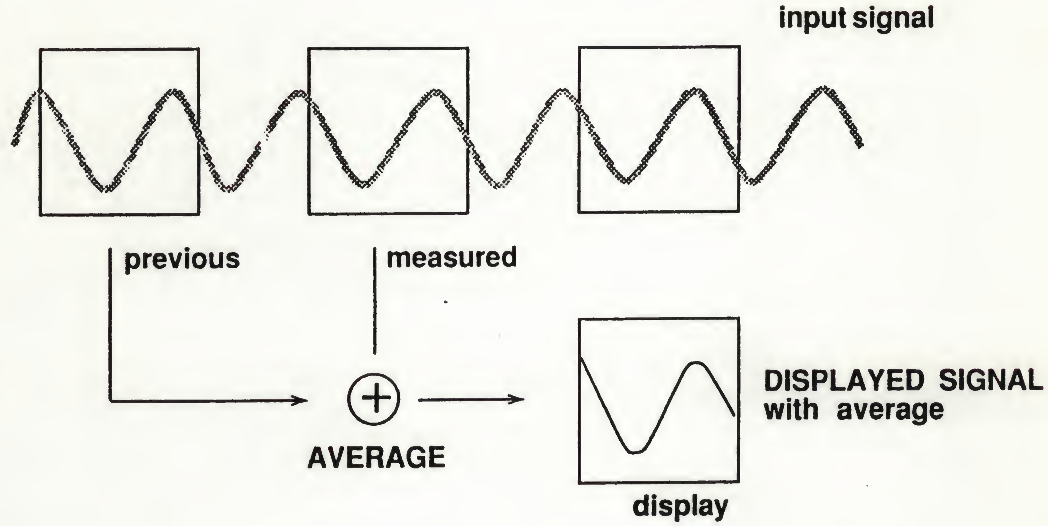
3' ZOOM in to this area to difine them

4 nsec resolution & -10 to +5000 div trigger delay

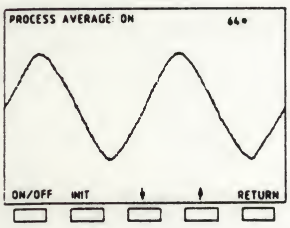
AVERAGE MODE

clean-up your signal

AVERAGE MODE



PROCESS AVERAGE menu



With this function you can suppress noise without loosing bandwidth. Every dot is calculated after every sweep in the following way:

$$\text{new} = \text{previous} + \frac{\text{measured} - \text{previous}}{C}$$

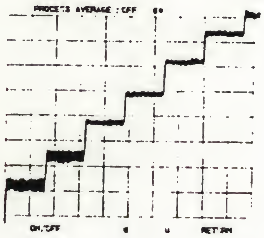
In this formula "previous" is a sample on the same position of the previous sweep. "C" is the average-factor; the bigger C is, the slower the dot positions change. The following values for C can be selected: 2, 4, 8, 16, 32, 64, 128 or 256.

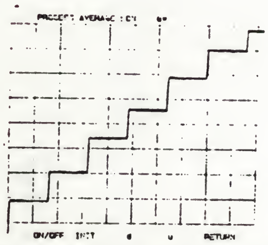
Once activated, AVERAGE is a continuous process until it is switched off. The process is started again when the INIT softkey is pressed or when the triggering or amplitude control is changed. In this case the display memory is cleared.

In SINGLE SHOT trigger mode the number of acquisitions is equal to the average factor C, in MULTIPLE SHOT trigger mode this number is twice.

DEMO / HANDS-ON

Measure from the sawtooth target the saw tooth signal
use the AVERAGE mode for cleaning the signal



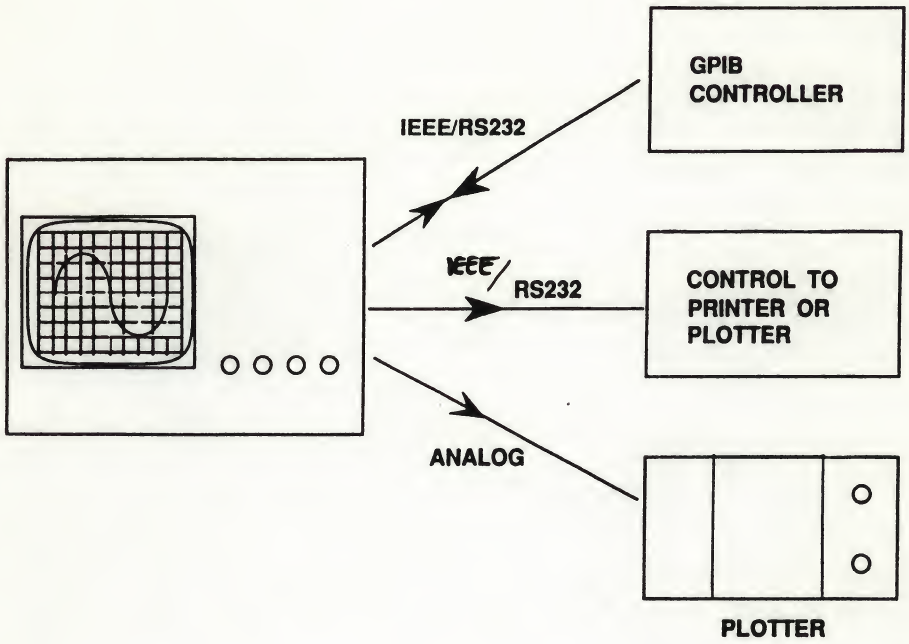


Use the Sawtooth Target

CHAPTER 3

INTERFACING

REMOTE CONTROL

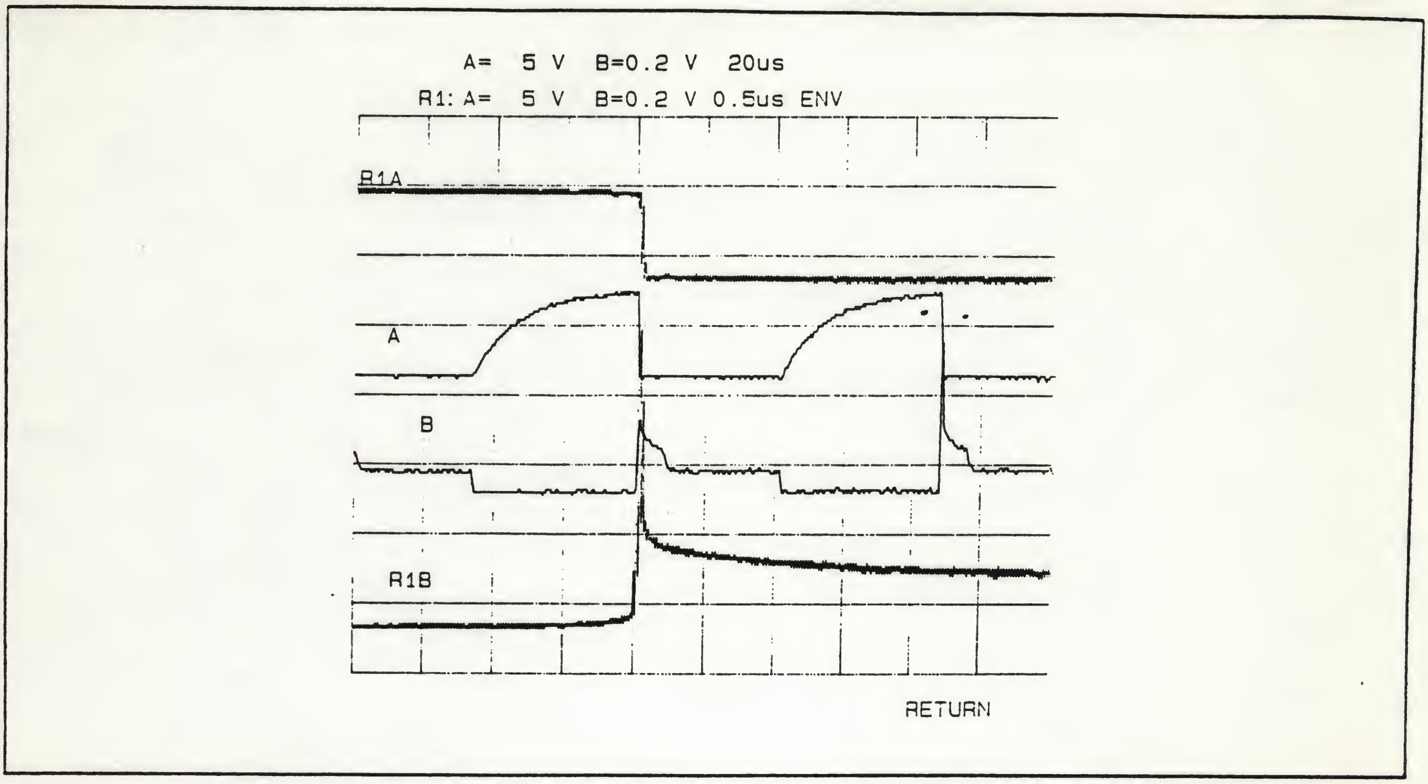


HARD COPY

DOCUMENTATION / CERTIFICATION

capture all from the CRT

cursors / calculation result etc.


A= 5 V B=0.2 V 20us
R1: A= 5 V B=0.2 V 0.5us ENV
R1A
A
B
R1B
RETURN

PLOTTING / PRINTING

0) Selection of interface : IEEE or RS232 (hardware)

1) Setup the interface channel : address // bit, baud etc

2) Setup the output device : typeno, size plot, AUTO?

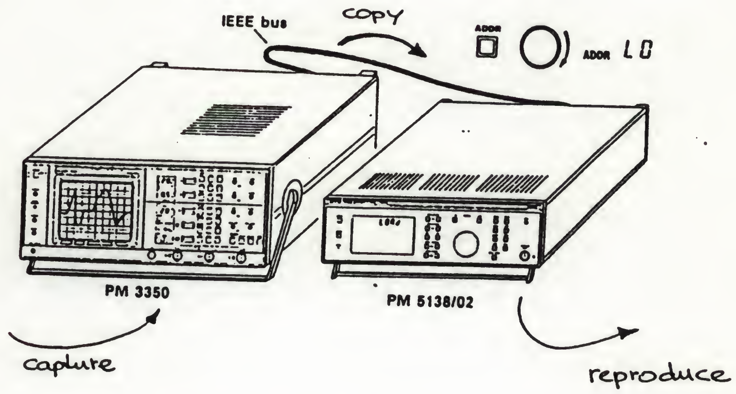
3) Select ONE device (KEY) : PLOT-D, PLOT-A, PRINTER

4) ACTIVATE action : PLOT key on the frontpanel

Reproduce for TESTING

Load in your generator your own captured Live signal, and repeat it FOREVER !

The FREQ. and/or AMPL can be varied



SPECIAL APPLICATION

Function generators with an IEC bus (PM 5138/02) are able to read in a stored signal of a digital storage oscilloscope, store these in an internal EEPROM and generate this signal as an output signal itself.

This allowes single signals, e.g. spikes or contact bouncing, to be reproduced for testing and measuring purposes when required using the generator. The frequency and/or the amplitude of this signal can also be varied.

All that is needed for the transfer is for the oscilloscope and the PM 5138/02 to be connected up together using an IEEE bus cable. Neither computer, the setting-up of programs, nor the knowledge of special commands of a programming language are required. The transfer is carried out in the plotter language HPGL. In this case the oscilloscope as "Talker" in digital plot mode must be set to transfer to plotter type PM 8153_6 via the IEEE interface. The generator is set to "Listener Only" by pressing the key ADDR and setting "LO" in the display using the rotary knob.

At the start of plotting (key PLOT on the scope), the generator shows the letters "LOAd" in the display as an indication that the transfer of data is running. When the transfer of data is complete, the generator is set to its last setting. When selecting the wave form ARB, the transferred signal is now available at the output of the generator. The amplitude and frequency of this signal can be altered within the permissible limits, whereby the relation of the maximum amplitude is proportional to the signal received from the screen of the scope. The full vertical range of the screen corresponds to the maximum voltage of 20 Vpp (open circuit voltage).

AUTOMATION

FRONTPANEL SETTING
programming and recall

GPIB CONTROL
BINPROG power

APPLICATIONS :
Production Tests
R&D : Repeated TESTS
Curve Adjustment
Signal Shape Adjustment

QUICK SET UP OF FRONT

on front panel		remote via GPIB
FRONTS SAVE	=	BINPROG ?
RECALL		BINPROG <..>
(memory softkey menu)		(read/write Controler)

ALL DSO FUNCTIONS
incl Envelope/Average Modes
incl Cursor position
incl Cursor measurement
incl Calculations
*) activate Cursor menu

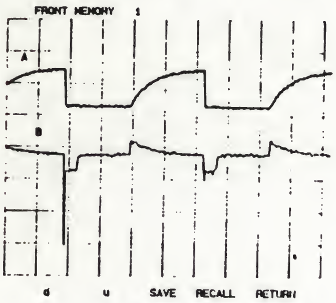
NOT TRIG LEVEL TRIG LEVEL with GPIB command !

DEMO / HANDS-ON

Define 2 frontpanels and save them for later use

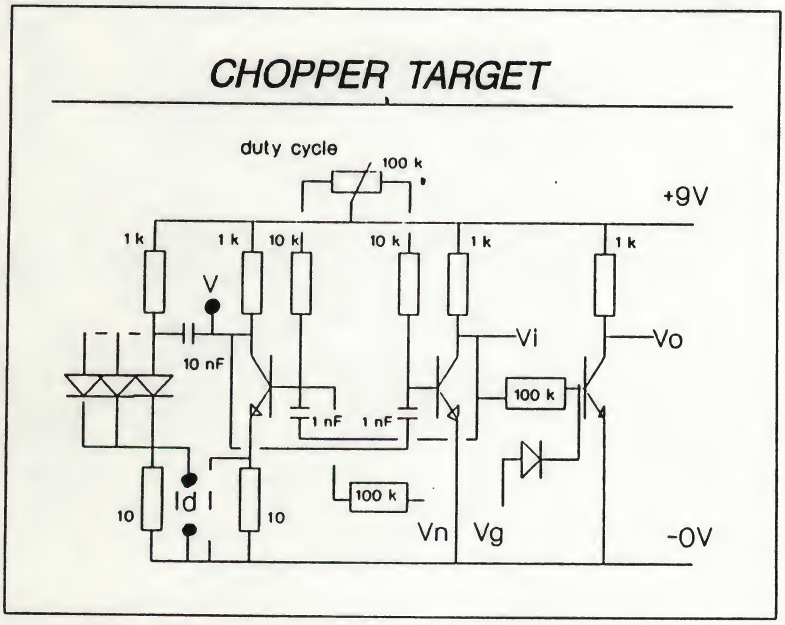
Both capturing the current and voltage
of a switching diode

Define 2 frontpanels and save them for later use

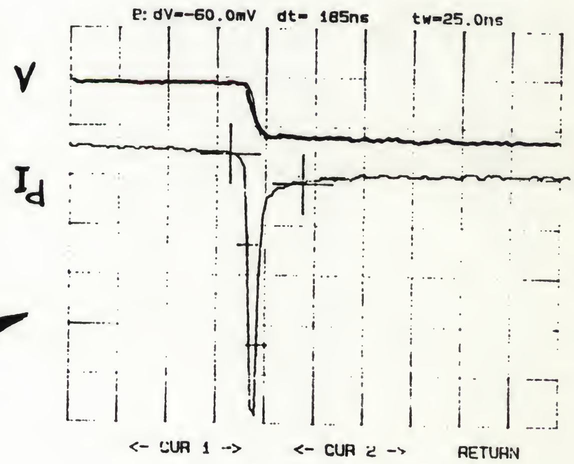


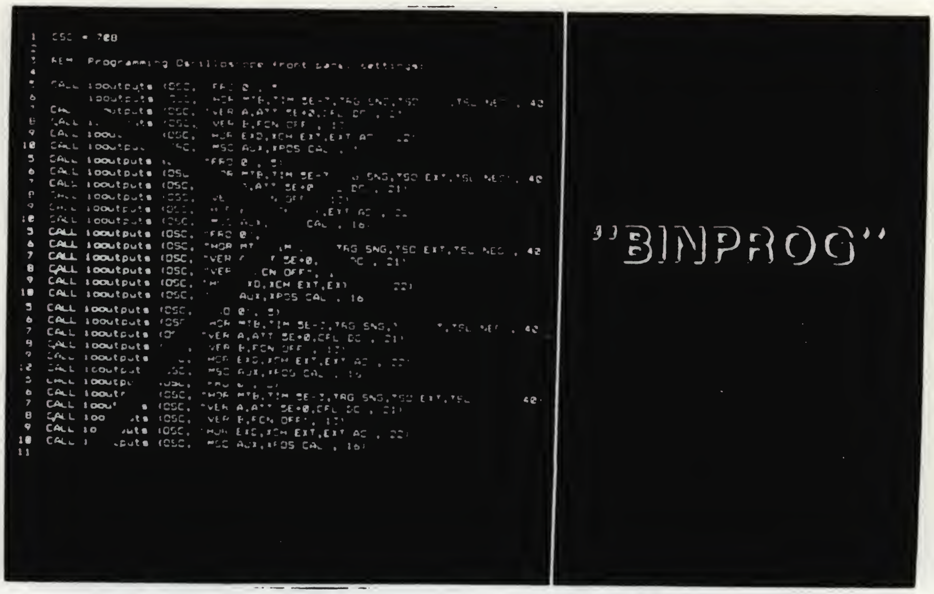
Use the Chopper Target

Zoom into the NEG areas
to define the REVERSE CURRENT



V
I_d




"BINPROG"

GPIB software: 2 product lines

* Software tools to make programming of instruments (or instrument set-ups) easier i.e. small production automation.

* Interactive data analysis software, with drivers especially for DSO's

GPIB software for programmers

PM 2201/99 GPIB interface card

PM 2201/52
- GPIB I/O routines
- I/O routines can be used with: GWBASIC, BASICA, C, PASCAL (MS)
- note: PM 2201/02
  PM 2201/52
  +
  PM 2201/99

PM 223*
- instrument drivers for high level control of Philips instruments
- package includes GPIB I/O drivers
- types:
  PM 2230: BASICA/GWBASIC
  PM 2231: C
  PM 2232: PASCAL
  PM 2233: QUICKBASIC

PM 2240- opt. 2241
- GPIB program-development environment
- instrument drivers and I/O procedures are included
- only suited for QUICKBASIC or C
- optional data-analysis library available (PM 2241)

Testteam: the complete GPIB programming environment

- Multiple windows
- Editor
- Instrument drivers
- GPIB I/O drivers
- Debugging facilities
- Graphics library
- Analysis library

GPIB software - ready to run

PM 2201/99

PM 2260

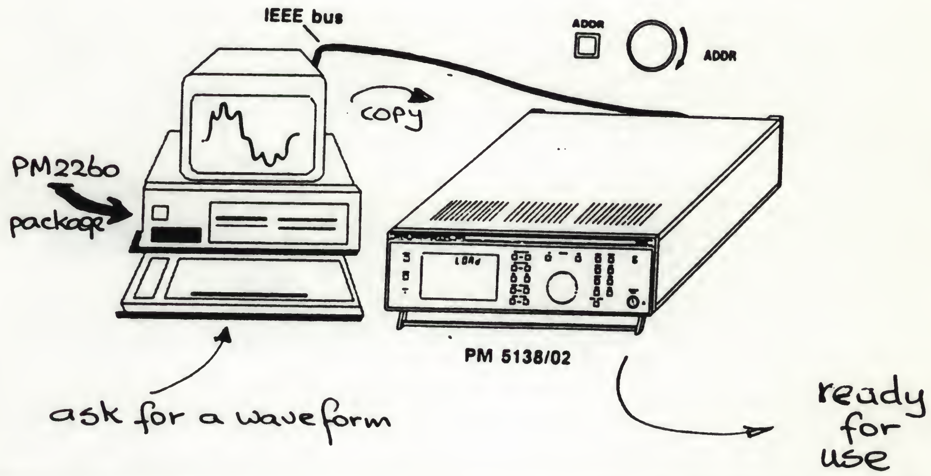
Q.S.P.

- Oscilloscope signal processing
- Interactive data analysis software package
- Only drivers for digital storage oscilloscopes available
- No programming skills required, software is completely menu-structured
- Powerful mathematics: FFT, powerspectrum, integration, differentiation, autocorrelation, ... many more

Create for REPRODUCTION

Mathematical Creation of your test signal with the OSP package (PM2260) !

The FREQ. and/or AMPL can be varied



some

APPLICATIONS

on

the

HIGH-TECH DSO's

PM 3320A

PM 3323

Price of this book : Hfl. .

A publication of Philips I&E

Test and Measurement - Training

Printed in the Netherlands

This course is primary designed as a "class-room" course.

In this way you will get the maximum benefit, having

immediate assistance of your teacher to assist you going

through the principles related exercizes.

The majority of subjects treated, are supported by measuring

exersizes; learn by doing !

* Cursor controlled Measurements : don't gamble , measure !
    Accuracy PM3323
    Cursor Controlled Measurement : position cursors
    Amplitude Relative locations
    DEMO/HANDS-ON
        Diode recovery time
    APPLICATION NOTES:
    1: D S O in Automated Test Environment
        Switching time of a component
        rise time on a ringing signal
        pulse width
        count pulse
        burst
        Diode recovery
        jitter
        readout SAVE / STOP on diff
    2: Semiconductor Testing
* Mathematical operation : Create your own Analyzer.
    DEMO/HANDS-ON
        MULT : power dissipation
* Min Max mode : continues information, between the sample moments
        Glitch detection
        Aliasing detection
        Envelope measurement
* Envelope Mode = Absolute min/max : jitter measurements.
    DEMO HANDS-ON
        Jitter measurement
* Stop and Save on Difference : Capture signals running Outside a Reference.
    Stop on difference
    Production control
    Processing modes STOP/SAVE
    DEMO HANDS-ON
        Intermittent faults
    APPLICATION NOTE
        Drift and Intermittent Faults
* Event Counting : extend the Pre/Post trigger delay
    Set-up of delay
    DEMO HANDS-ON
        Video line selection
* Waveform characteristics
    DEMO HANDS-ON
        FFT and RMS , introduction on FFT
* Average : cleaning-up your signal
* Miscellaneous
    Filter function
    Offset and vertical resolution
    Distributing acquired signals
* Hard Copy : Documentation and Certification
    Set up Plot/Print
    example
* Automation
    Fronts
    DEMO/HANDS-ON
        Frontpanel
* Softkey Menus

CURSOR CONTROLED MEASUREMENTS

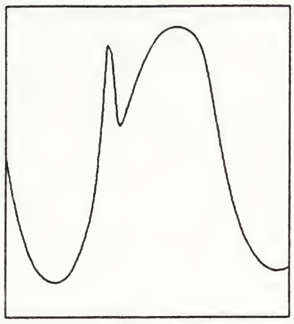
don't gamble, measure!

PM3323

ACCURACY

Cursor measurement

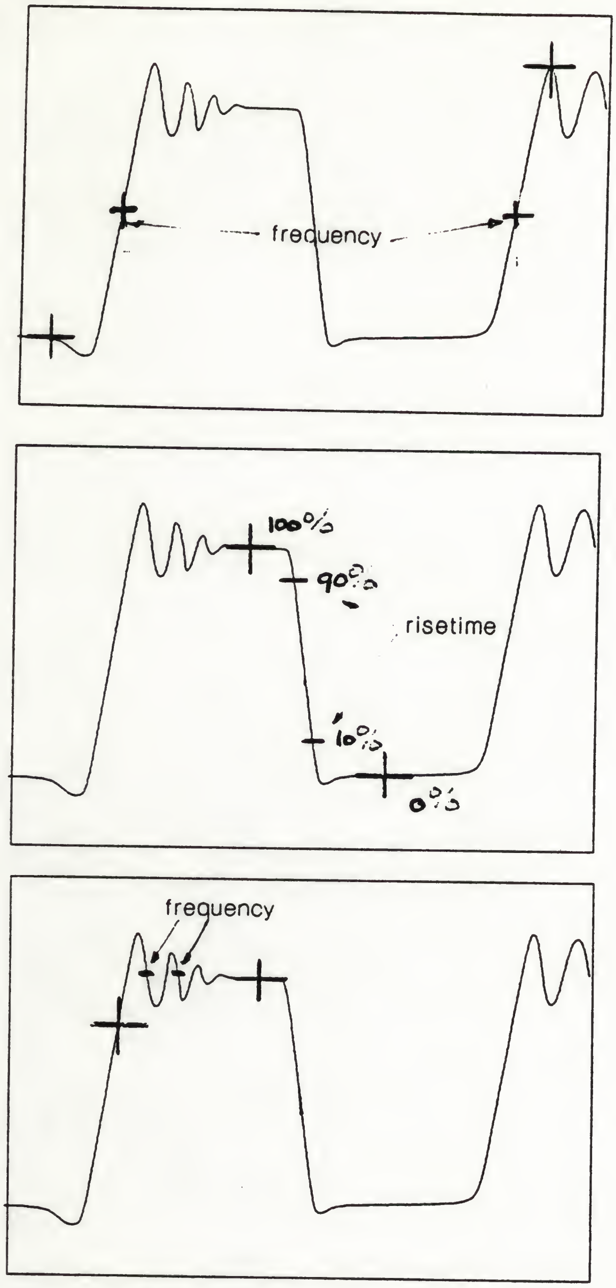
1024 / 10 div
resolution 0.01 %
at 10 div
2.0 %



10 x 10 div

4096 / 512
resolution 0.025 / 0.2 %
at 10 div
up to memory 0.01%
0.2 %

CURSOR CONTROLLED MEASUREMENTS



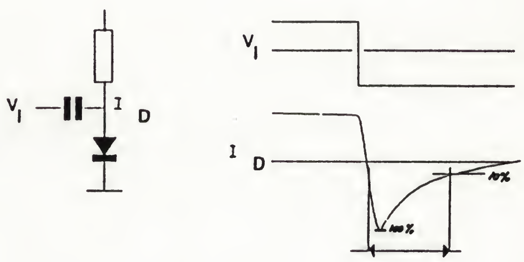
predifined measurements
in respect to the cursors position !

NOTE : Select first the calculation to be done. Then adjust the cursors to the right place on the traces to get the wanted measurement as indicated by the system with the markers.

CURSOR CONTROLLED MEASUREMENTS

AMPLITUDE relative located cursors

Component testing
Diode Reverse Recovery Time



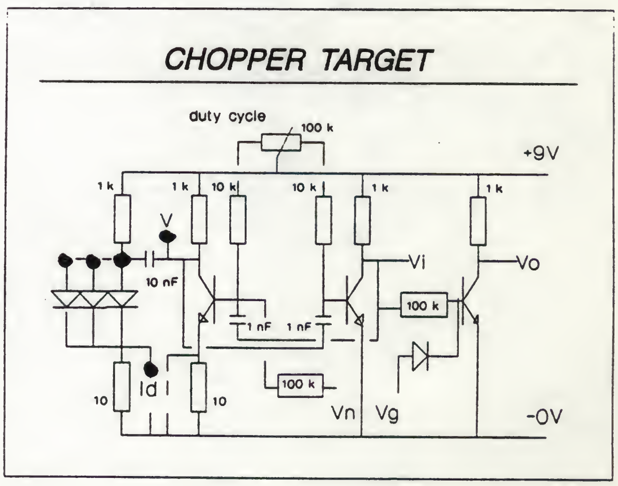
after changing the DIODE , the cursors automaticly position themself on the new trace

Reference to: 1) Digital Storage Oscilloscope in Automated Test Environment (august 1989)

2) Semiconductor Testing (Appl note PM 3340, august 1988)

V

Id



PHILIPS

Digital Storage Oscilloscopes in Automated Test Environment

Introduction

Digital Storage Oscilloscopes or DSO's are used nowadays more than ever before in Automated Test Environment for in-line measurements. At the same time the "intelligence" of the instrument has increased enormously. This allows for powerful measurements where the instruments themselves take the decision "pass" or "fail" instead of an operator who has to "eyeball" the displayed waveform.

Starting early 1989, Philips equipped it's PM3320A 250 MS/s DSO and PM3340 2 GHz digitizing oscilloscopes with improved software, giving more measurement power and extended control via the bus.

In the spring of this year the PM3323 500MS/s DSO was introduced, having the same powerful capabilities as the PM3320A plus the advantages of the higher sampling speed.

This application note deals with the application of the Philips oscilloscopes PM3320A, PM3323 and PM3340 in automated test environment. Included are some examples of "real world" measurements, the required instrument set-ups plus examples of command strings that can make the same set-ups via IEEE-488 or RS232 remote control.

1. Cursor positioning

Measurements are done using two independent cursors that are always located on the signal. They can be positioned on the same or on different signals, in the same or in different registers R0 ... R3. This allows for propagation delay measurements, switching time measurements and many more, even between the contents of a register and an actual signal.

In the TIME mode cursors can be shifted in horizontal direction. This enables you to measure the amplitude of the signal at specified moments or to position the cursors under visual control.

In the AMPlitude MODE cursors are located on the signal crossing a user definable amplitude level. This can be an absolute or a relative level.

For optimal accuracy of absolute levels, the instrument is equipped with a CALIBRATE function that a.o. compensates for offset changes due to temperature variations during warm-up.

The use of relative amplitude (RELTV AMP) levels allows you to locate each cursor on any signal value in between - 50% and + 150% relative to the user definable 0% and 100% reference levels.

The reference levels can be chosen for each cursor independently as:

- MIN PEAK the most negative signal value measured
- MAX PEAK the most positive signal value measured
- GROUND the system ground level.
- ABSOLUTE an absolute voltage level, adjustable with the rotary for the first or second cursor control
- PROB LOW the voltage level corresponding with the bottom flat part of the trace, derived from the amplitude-histogram of the signal
- PROB HIGH the voltage level corresponding with the top flat part of the trace, derived from the amplitude-histogram of the signal.

Using PROB HIGH or PROB LOW eliminates the influences of overshoot, preshoot and ringing on time measurements.

The reference values for each cursor can be displayed as dotted lines, without affecting the position of the cursors (DISPlay REFerenceS). For optimum visibility of signal detail, these reference levels are not plotted on hardcopies.

The SEARCH feature enables you to find the n-th occurrence (n ranging from 1 up to 9) of a specific level, counting from LEFT to right (SEARCH n-->) or from RIGHT to left (SEARCH <--n).

In this way you can measure the pulse width of a specific pulse in a pulse train or the risetime of a specific edge.

By combining the SEARCH LEFT for one cursor with SEARCH RIGHT for the other, one can measure the duration of a burst of pulses. By measuring on the result, captured through the ABS. MINMAX over time of a pulse with variable duration, one can measure the amount of jitter.

1.1. Switching time of a component

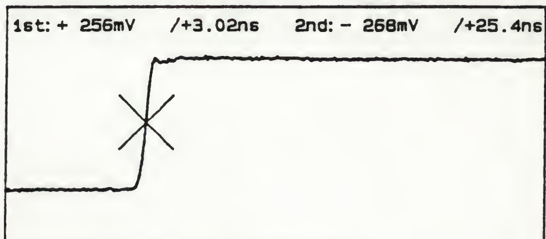
Suppose you want to measure the switching time of a series of components, measured between the moments the input and output signals cross the 50% amplitude level.

How to set up the instrument?

Press the AUTOSET after the two signals have been applied to the instrument. Speed up the timebase to a setting that allows you to see the required edges of both signals (like in figure 1).

Set the first cursor to the 50% level of the input transition on channel A, the second cursor to the 50% level of the output waveform on channel B.

To eliminate the influences of overshoot and ringing, select the peaks of the amplitude histogram (PROB LOW and PROB HIGH) as 0% and 100% references.




```
COMMAND STRING
spl cursor
cur type_2
first_cursor A
second_cursor B
cur volt
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
first 2049
for second_cursor
mod relative
for ref_0
reference prob_high
for ref_100
reference prob_low
second 2049
```

Figure 1. Switching time measurement

Select the CURSOR/ANALYZE menu, ON + or ON X, 1st R0-A, AMP (not the TIME-mode), AMP MODE , RELTV (relative amplitude), REF 0% , PROB. LOW, MORE (100%), PROB. HIGH, RETURN, SEARCH 1--> and turn the rotary for 1st cursor control until the center text line in the softkey area reads + 50%.

Press RETURN, MORE (2nd), R0-B, AMP MODE, RELTV, REF 0% , PROB HIGH, MORE (100%), PROB LOW, RETURN, SEARCH 1--> and turn the rotary for 2nd cursor control until the center text line in the softkey area reads + 50%.

The time between the two cursors equals the switching time and can be read as dX:...ns in the far right of the top text line on the screen.

It can also be read in the bottom text area if the front text mode is switched to RESULTS (see part 2 of this application note).

In figure 1 a plot-out of the resulting display is given.

Note: *Every time SEARCH n--> is pressed, the number n is increased by one, until n equals nine where an extra increment brings it back to n = 1. When the direction for searching is changed, n is reset to 1. However, if SEARCH n--> is mentioned in these examples, it means that the softkey must be depressed so often until the text SEARCH n--> is highlighted with the value n.*
So for SEARCH 1-->, this softkey must be depressed until the text reads "SEARCH 1-->".

1.2. Risetime measurement of a signal with aberrations

In figure 2 we can see an example of a risetime measurement on a signal with a lot of ringing. Still the risetime between 10 % and 90% is to be found, where 100% is the final value of the pulse after the aberrations have stabilized. In the automatic risetime measurement (found in the same menu as PULSE WIDTH, see below) the cursors are seen as the 0% and 100% levels. This forces the operator to manipulate the cursors to the correct horizontal position, which can vary in a series of measurements on similar systems.

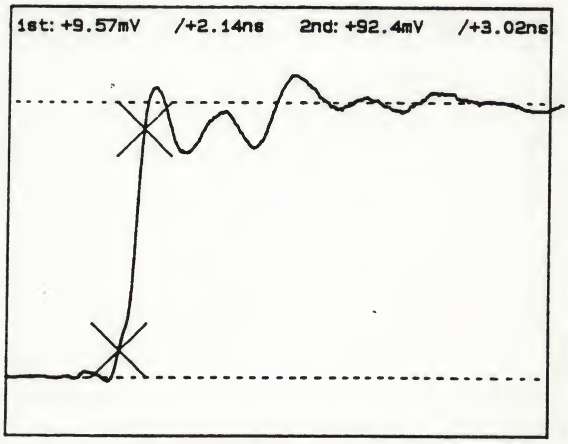


Figure 2. Risetime measurement.

```
COMMAND STRING
spl cursor
cur type_2
cur volt
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
search left
search 1
first 1229
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
search left
search 1
second 2868
```

After once setting up the instrument like shown here, the instrument can do the measurement fully automatically, without requiring any action from the operator.

Press CURSOR/ANALYZE and activate either type of cursors.

Select 1st:R0-A, AMP, AMP MODE, RELTV, SEARCH 1-->, REF 0% , PROB. LOW, MORE (100%), PROB. HIGH, RETURN and adjust the first cursor control for a + 10% level, indicated in the center text line in the softkey text area. Press RETURN, MORE (2nd), AMP MODE , REFerences AS 1st, SEARCH 1--> and adjust the rotary for second cursor control for a 90 % level indication.

The time between the two cursors now equals the risetime and can be read in the upper right of the screen as dX:...ns.

1.3. Pulse width measurement

The instruments allow for two ways to measure the pulse width.

1.3.a. If the 50% level crossings are used for pulse width measurement, the set-up is as easy as this.

Press CURSOR/ANALYZE and activate the cursors in either shape.

Press 1st:R0-A, TIME (not the amplitude mode), RETURN, MEASURE , TIME , PULSE WIDTH. Now on the lower left of the screen the pulse width is indicated. Pressing MARKER will also activate two markers (small horizontal lines) indicating on what signal level the measurement is done. This is always on the 50% level of the peak-peak value of the signal in between the two cursors.

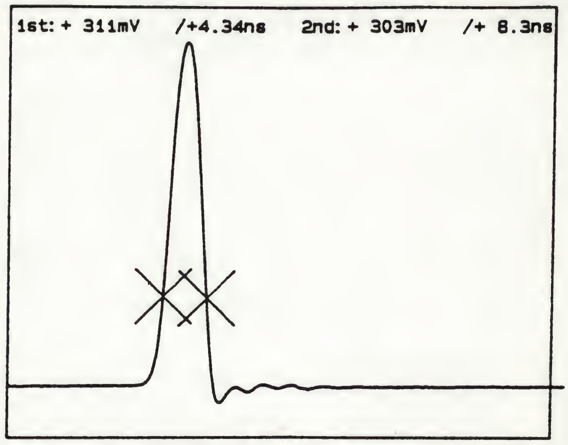


Figure 3. Pulse width measurement between the 25% level crossings.

```
COMMAND STRING
spl cursor
cur type_2
cur volt
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference max_peak
first 1537
search left
search 1
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference max_peak
second 1537
search right
search 1
```

1.3.b. If the pulse width is to be measured on another level than half-way the peak-peak level of the signal, the following sequence can be used (it is assumed here that a positive pulse is applied).

Press CURSOR/ANALYZE and activate the cursors in either shape. Press 1st:R0-A , AMP (not the time mode), AMP MODE , RELTV (relative amplitudes), REF 0% , PROB LOW, MORE (100%), PROB HIGH, RETURN, SEARCH 1--> and turn the rotary for first cursor control until the center text line in the softkey area reads the desired relative amplitude.
Press RETURN, MORE (2nd), AMP MODE , REFerences AS 1st, SEARCH<--1 and turn the rotary for control of the second cursor until the desired relative amplitude is indicated.

Now the time between the cursors equals the pulse width between the relative signal levels chosen.

The plot in figure 3 has been made this way, where both cursors were at 25% of the amplitude between the lower flat part and the maximum peak.

1.4. Measurement of the pulse width of a specific pulse in a pulse train

This is the same set-up as described in 1.3.b., except for the SEARCH 1--> for the first cursor that is now to be replaced by SEARCH m-->, where m = the number of the edge on which the measurement is to start (see figure 4).

Since the second cursor is always placed to the right hand side of the first one and searching level crossings starts at the position of the first cursor, the set-up for the second cursor remains SEARCH 1-->.

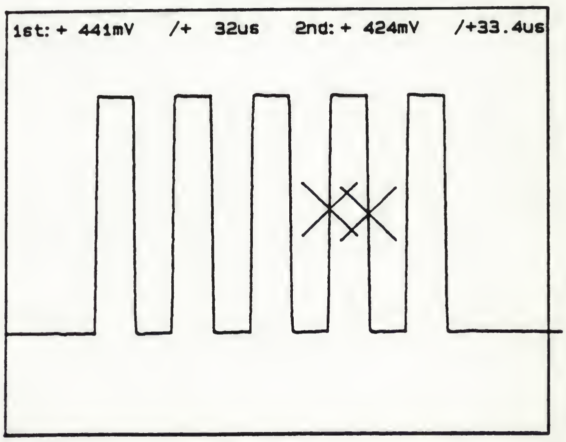


Figure 4. Pulse width measurement of a specific pulse.

```
COMMAND STRING
spl cursor
cur type_2
cur volt
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
first 2049
search left
search 7
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
second 2049
search left
search 1
```

1.5. Measurement of the duration of a burst of pulses

In order to measure the duration of a burst of pulses, the set-up as mentioned above in section 1.3.b can be used.

This will result in a display like in figure 5.

For signals that contain so many pulses in a burst that the individual pulses are no longer seen, the use of the built-in peak detectors (PM3320A and PM3323 only) is recommended. They are activated by selecting the VERTICAL MODE menu, PROCESSING , MIN/MAX. The peak detectors are capable of capturing 3 ns wide pulses.

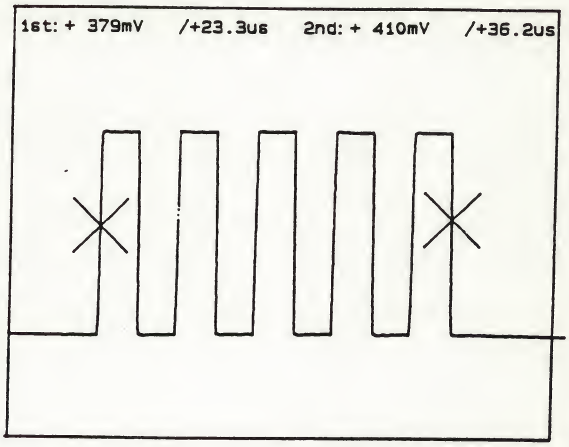


Figure 5. Duration of a burst of pulses.

```
COMMAND STRING
spl cursor
cur type_2
cur volt
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
first 2049
search left
search 1
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
second 2049
search right
search 1
```

1.6. Measurement of diode reverse recovery time

If a diode is switched from conducting to non-conducting state, the charge built up in it must be carried off before the diode blocks reverse current. The amount of time it takes to do so is called the reverse recovery time. The time is usually measured between the moment the diode carries no current and the moment the current is decreased by 90% of its peak reverse value (see figure 6 and 7).

This is how to set up the cursors.Select the CURSOR/ANALYZE menu, switch on the cursors in either shape and press 1st R0-A, AMP (not the TIME-mode), AMP MODE , RELTV (relative amplitude), SEARCH 1-->, REF 0% , GROUND, MORE (100%), GROUND (both references at ground level will bring the first cursor at ground level), RETURN, RETURN, MORE (2ND), AMP. MODE , RELTV, SEARCH 1-->, REF0%, MIN PEAK, MORE (100%), PROB LOW, RETURN and turn the rotary for second cursor control until the center text line in the softkey area reads + 90%.

The time between the two cursors now equals the reverse recovery time and can be read in the upper right of the screen as dx:...ns.

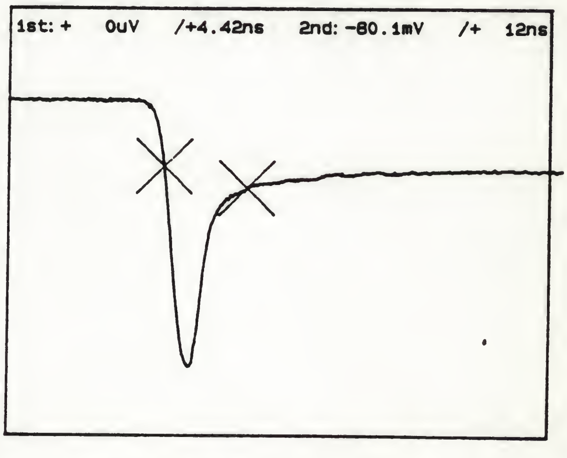


Figure 6. Diode reverse recovery time.

```
COMMAND STRING
spl cursor
cur type_2
cur volt
for first_cursor
mod relative
for ref_0
reference ground
for ref_100
reference ground
first 2049
search left
search 1
for second_cursor
mod relative
for ref_0
reference min_peak
for ref_100
reference prob_low
second 2868
search left
search 2
```

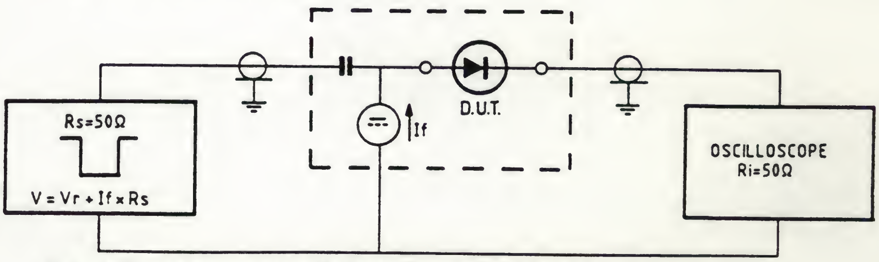


Figure 7. Test circuit for reverse recovery time measurement.

1.7. Automatic pulse jitter measurement

Suppose there is a positive pulse with variable pulse width. You want to measure the amount of jitter on the falling edge. This can be done fully automatic, independent of the signal amplitude.

We can build an envelope of the jitter over time, being the area where the pulse spreads, and measure the time between the first and the last falling edge found, crossing the 50% levels.

Select the positive trigger slope.Set the timebase and the trigger delay in order to display only the falling edge and to give room to the (expected) amount of jitter. The delay must be at least one division, in order to have the rising edge off the display. Make sure no positive transition is visible on either side of the screen.

Select DISPLAY-menu, REG. SELECT, R0 ON, R1 ON.

Make an envelope of the jitter in register 1: select VERTICAL MODE, PROCESSING, ABS. MINMAX, START.

Make sure the result register is R1 (default). Don't use the AUTO ERASE possibility.

Select the CURSOR/ANALYZE-menu, CURSORS SELECT, ON + or ON X, 1st R0-A, R1 A, AMP (not the TIME mode), AMP MODE , REF 0% = PROB. LOW.MORE (100%), REF 100% = PROB. HIGH, RETURN.

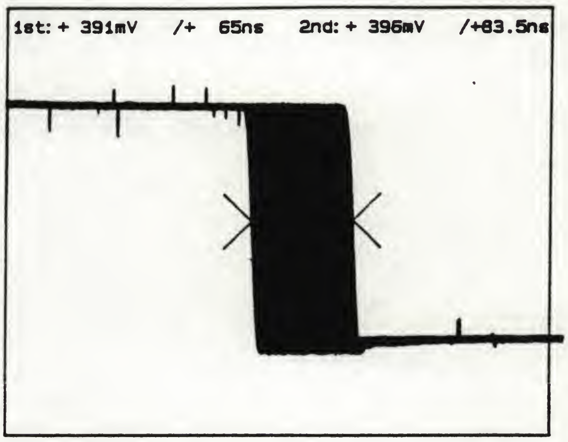


Figure 8. Jitter measurement .

```
COMMAND STRING
spl cursor
cur type_2
cur volt
first_cursor r1
second_cursor r1
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
first 2049
search left
search 1
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
second 2049
search right
search 1
```

Turn the rotary for control of the first cursor position until the central reading in the softkey text area is at + 50% . Have the system to search for the first occurrence of the 50% level from the left side of the screen: SEARCH 1-- >, RETURN.

Select the reference levels and the positioning for the second cursor: MORE (2nd), CURSOR 2nd at R1 A, AMP. MODE , REF. AS 1st.

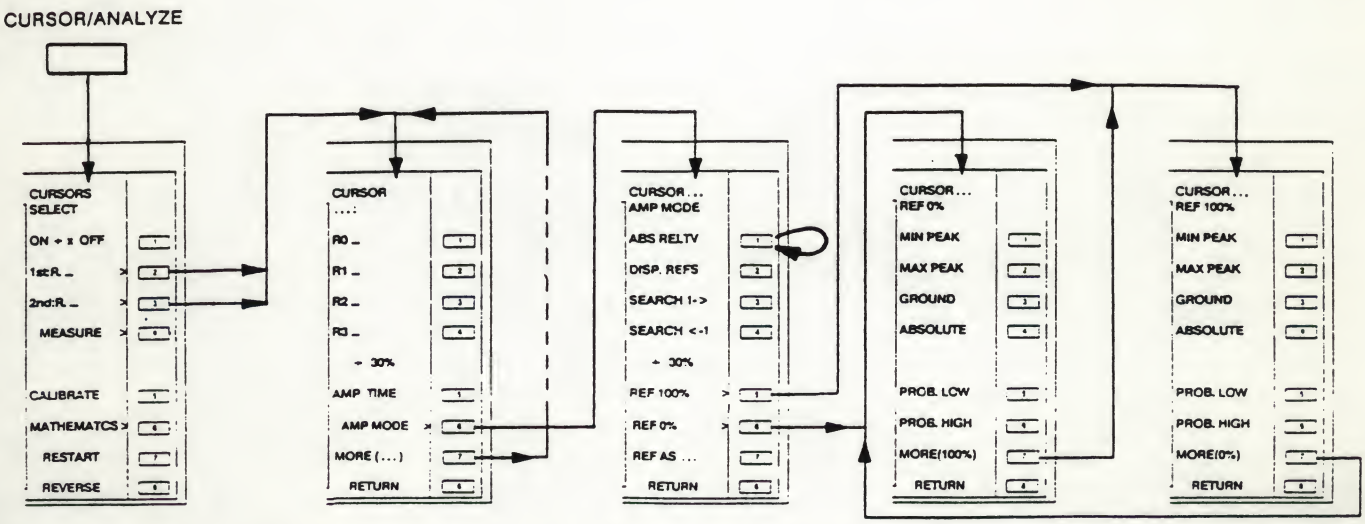


Figure 9. The part of the cursor menu, used for relative amplitude measurements.

Turn the rotary for second cursor control until the central reading in the softkey text area is at + 50% and have the system to search for the 50% level in the last edge on the screen (the first edge when counting from right to left) by pressing SEARCH <--1, RETURN, RETURN.

The dX-reading in the upper right of the screen equals the amount of jitter of the edge in seconds.

By pressing AUTO ERASE in the ABS. MINMAX menu the envelope is cleared every ten seconds or 100 acquisitions. Pressing it twice clears the register and starts the function again for an unlimited amount of time.

2. Clear read-out of the result of the SAVE or STOP ON DIFFERENCE

The display menu has been expanded with a direct read-out of the result of the SAVE or STOP ON DIFFERENCE function.

Opening the display menu and pressing the FULL TEXT softkey, shows a menu with a softkey labelled 'RESULTS'.

Activating this function, the bottom text area on the screen is used to display the resulting time- and voltage differences dX and dY between the two cursor positions. However, if the SAVE or STOP ON DIFFERENCE function is active, this text area displays solely the result ENVELOPE FAIL or ENVELOPE PASS. This can be very convenient if one is interested in this test result only, without the need to observe the actual waveform.

3. Expanded RESTORE capability

In previous versions of the PM3320A and PM3340, it was possible to store the contents of the acquisition register R0 in another memory and use it as a reference for the SAVE or STOP ON DIFFERENCE function.

Now the RESTORE function in these instruments and in the PM3323 does much more:

- it stores the contents of the acquisition memory in one of the other memories R1 ... R3,
- and it starts the ABS. MINMAX functions in the same register, building the envelope of the signal as it is acquired over time.This is the same function as the ABS. MINMAX function in the vertical processing menu. While the function is active, the softkey-text 'RESTORE' is displayed intensified.

Pressing the RESTORE softkey again stops acquiring data for the envelope.

4.Expanded bus facilities

For instruments with the IEEE/RS232 interface PM8956A installed, two more changes can be of great value: the bus learn facility and the expanded status register.

4.1. Storage of front panel settings

Not only is it possible to store the complete set-up of the instrument in one of its 251 built-in set-up memories, it is also possible to send the complete set-up to a controller that can store it for future use.

To do so, the command 'BINPROG ?' is enough. The oscilloscope will reply by sending two strings, that contain all information on the setting of all front panel controls in a short format. These strings can be stored in the controller and can be sent to the oscilloscope whenever

the same set-up is required.
Therefore, you can make the set-up for a measurement manually and check it, as soon as the set-up is found to be correct you can store it either internally or send it to your controller.

Using 'BINPROG' relieves you from programming all individual set-up parameters.

4.2. SRQ-handling, Device Status Register and Device Status Enable Register

If the instruments has information for the controller, a service request (SRQ) is sent to the controller to attract its attention. After receiving this, the controller checks which instrument in the system generated an SRQ and reads the status register of the instrument concerned. The status register provides information on the status of the instrument. This may be:

- the oscilloscope has generated a service request
- a measurement (a programmed action) is in progress
- the interface or the instrument is in an erroneous condition.

After the instrument has generated a service request (SRQ), and it is indicating in the status word an erroneous condition was met, one can read the 'device status register' (DESR) to get more information on what caused the SRQ:

- a new acquisition was compared to the reference in SAVE or STOP ON DIFFERENCE
- a new acquisition was compared to the reference and some part was found to be outside the reference ('ENVELOPE FAIL')
- autoset was finished
- calibration of the instrument was finished
- a mathematical function was activated or was finished
- a cursor measurement was activated or was finished
- a single shot or single scan acquisition was started or was finished.

Reading the device status register will automatically clear all bits of it.

By loading the 'device status enable register', one can select which event will generate an SRQ by loading the appropriate bit. For instance: making status bit 2 equal to 1 (decimal equivalent =4), an SRQ will be sent as soon as a measurement falls outside the envelope in STOP ON DIFFERENCE.

Refer to the interface PM8956A/01 instruction manual chapters 4.7, 4.8 and 5.5 for full detailed information.

Note: *The software mentioned here has often been referred to as 'the V03 software'. However, software in your instrument may have been updated and may therefore have a higher release number with the same or improved performance.*

Application Note PM 3340

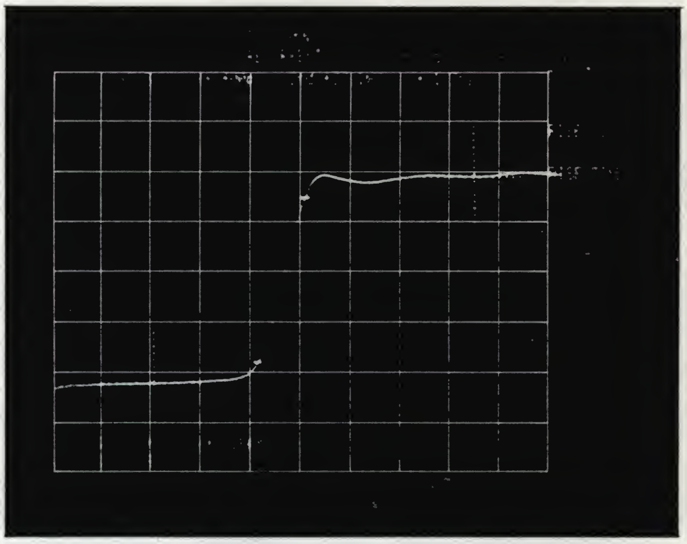
SEMICONDUCTOR TESTING

INTRODUCTION

Testing of semiconductors - transistors, diodes, integrated circuits - require quick, accurate and reproducible time interval measurements.
The PM 3340 digitizing oscilloscope provides excellent possibilities for both manual and automatic measurements.
A response time of 175 ps meets the requirement of up to the fastest devices while the flexibility of cursor manipulation permits measurements on any detail of the input signals.

This application note deals with the most important measurements in this area.

1.PULSE RISETIME (t_r)



The RISETIME mode provides automatic risetime (or fall time) measurements at selectable percentages of the pulse amplitude.

The 0 % and 100 % reference values are set by the cursors.

Rise time limits are selected at:
- 10 % and 90 %
- 20 % and 80 %
- any individual percentage

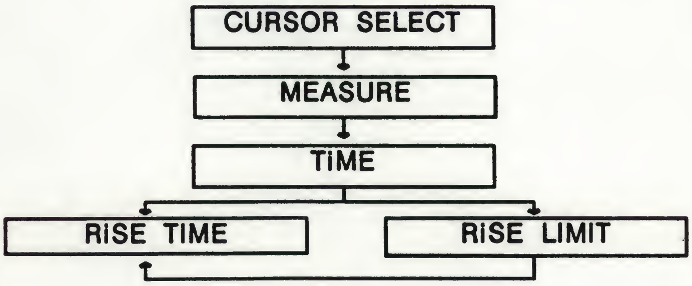
These limits can be shown by markers on the waveform.

The resulting rise time is shown in the lower screen text line.

e.g.: RISE : + 192 ps

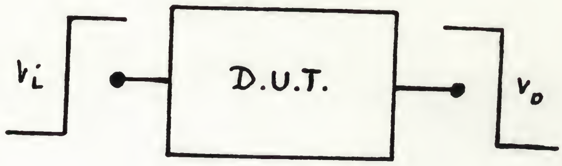
A minus-sign in the result shows a fall time measurement. If the markers are selected also the time differences between the markers and the start of waveform are displayed.

The cursor/analyze menu provides rise time measurements in 4 steps.



2.PROPAGATION DELAY (t_p)

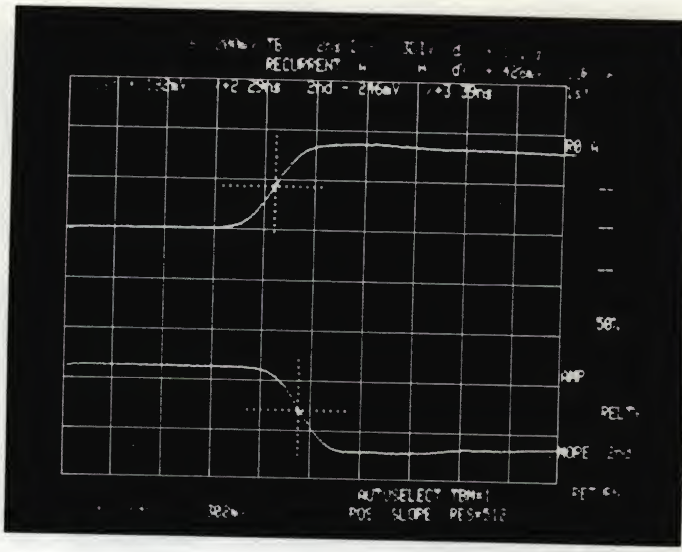
This measurement deals with time interval measurements between the input- and output signals of a device.
The waveforms are displayed via channel A and B, while triggering occurs via channel A.



The propagation delay can be defined as the time interval between signals points related to the signal amplitude e.g. 50 % of the signal amplitude or related to ground level.

t_p RELATED TO SIGNAL AMPLITUDE

If related to signal amplitude the required percentage of the peak to peak signal amplitude is set for each individual signal in the **AMP - RLTV** (amplitude - relative) mode. The percentage appears in the menu selection part of the screen.

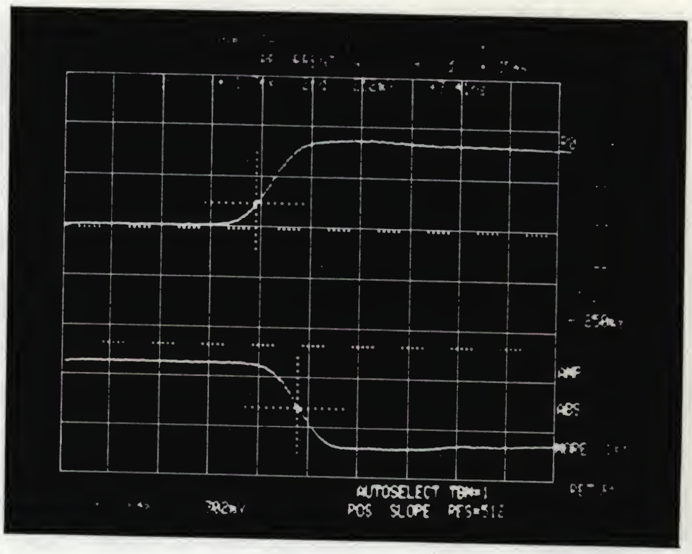


Menu Selection:

CURSOR SELECT
↓
CURSOR 1st/2nd
↓
AMP - RELTV

The required precentages are set by means of the cursor controls.
Result appears in upperscreen line. e.g.: **dX: + 1.1ns**

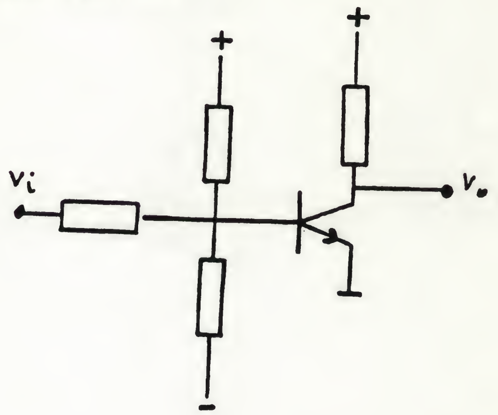
t_p RELATED TO GROUND



The cursors are now used in the AMP-ABS (amplitude - absolute) mode and individually set at the required voltage level related to ground.The ground reference can be displayed on screen(GROUND IND).
If the voltage levels should not refer to the ground value but to other levels, these levels can be set in the **INCL OFFST** (including offset) mode by means of the offset controls.
These new reference levels can be selected individually for each channel, and are displayed by two broken reference lines.

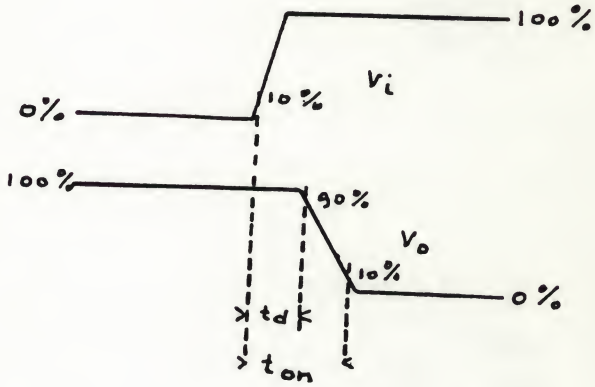
3.TRANSISTOR TURN ON/TURN OFF TIMES (t_{on}, t_{off})

These parameters specify the speed at which transistors switch from the cut-off state to saturation (or from saturation to cut-off) which includes the internal delay and the output signal rise time.



Reference is made to the diagrams shown:

The turn on / turn off times are defined as the time intervals between 10 % of V_i and 10 % of V_o.



Using the **AMP-RLTV** mode these percentages can precisely be set and the measuring result is displayed as e.g.: **dX: + 2.25 ns** on the screen.

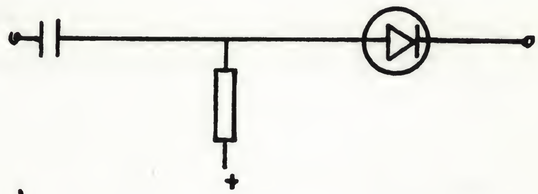
By readjusting the output signal cursor to a percentage of 90 %, the transistor delay time t_d is measured.

Since the cursor percentages relate to the peak-peak signal values the actual amplitude does not influence the measurement. This means that this measurement can be repeated with other transistors without the need for readjustment of cursor settings; the new measurement result will automatically appear on screen.

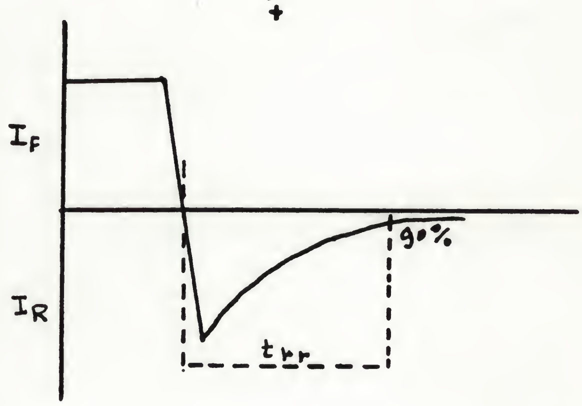
4.DIODE REVERSE RECOVERY TIME (t_{rr})

When a semiconductor rectifier diode has been conducting in the forward direction, there will be a charge due to minority carriers present.
This charge must be extracted before the device can block in the reverse direction.
The reverse recovery time is specified as the time interval between the instant the current passes through zero (from forward to reverse) and the instant the reverse current has been decreased to 90 % of its peak value.

Measurement diagram:



The output waveform:



This measurement requires the **TIME** mode allowing the cursors to be placed individually to any part of the waveform. This makes it possible, otherwise than in the **AMP** mode, to measure between leading and trailing edges of one signal.

Menu Selection:

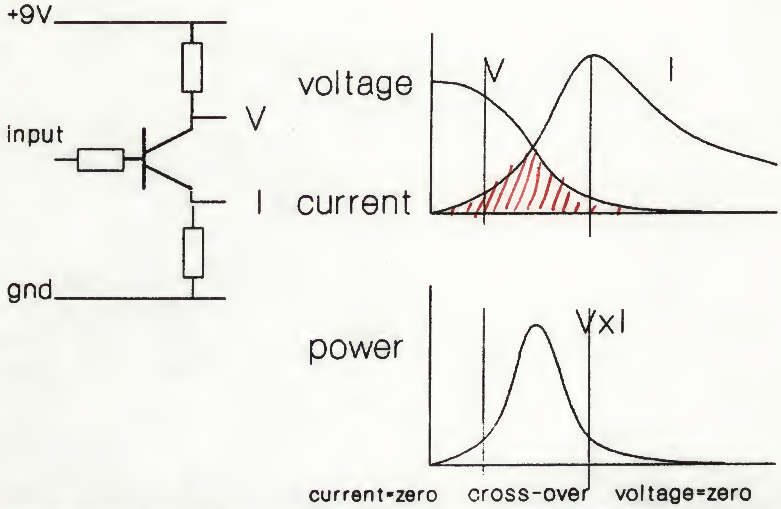
CURSOR SELECT
↓
CURSOR 1st/2nd
↓
TIME

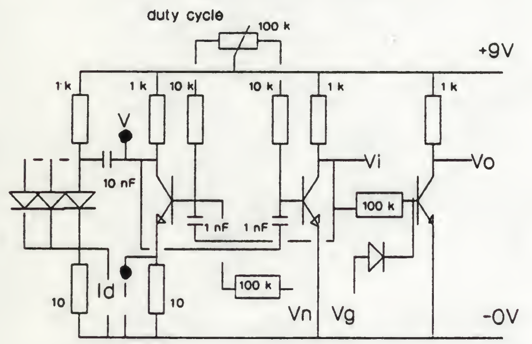
MATHEMATICAL OPERATIONS

create your own Analyzer

MATHEMATICAL OPERATION

multiply two traces





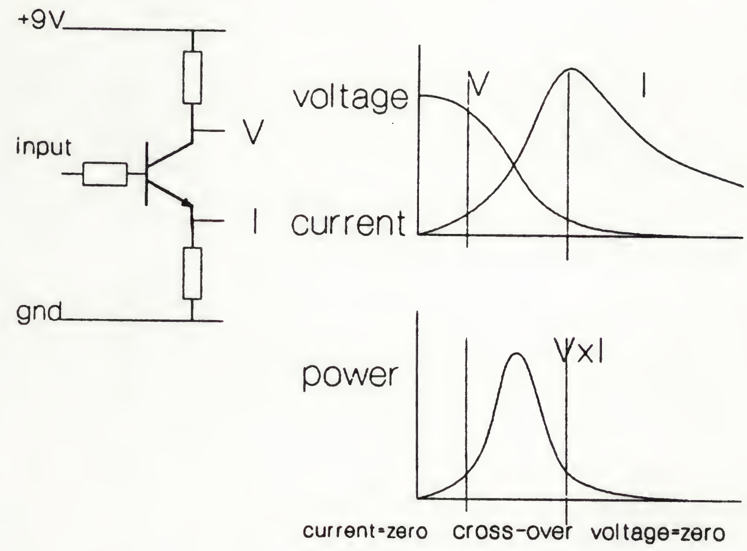
V
I } * = power

FAST SWITCHES: MOSFETS / POWER DISSIPATION.

APPLICATION AREA think of :

Power supply industry : switching transformers, telecommunication industry : class C or D end stage transmitters, ...

INTRODUCTION :



The dissipation of the transistors or FETs in power switching is limited to the ON and OFF going states. To adjust these 'cross over' dissipation, in f.i. R&D or production, a power calculating tool on the VOLTAGE and CURRENT traces is necessarily.

The PM3320A offers a MULTIPLICATION and INTEGRATION option to serve this.

EXERCISE 1 :

-----exercise-----	--knob control--	---- comment -----
set up the representing signals for the VOLTAGE and CURRENT (pin 'V' and 'I')	AUTOSET, set TIME/DEV, TRIGGER DELAY, down (to -1div),	adjust to the interesting 'cross over' on one acquisition sweep.
	VERTICAL MODE, COUPLING, DC both channels,	DC signals !
	DISPLAY, REG SELECT, R0 on, R1 on,	
and multiply them;	CURSOR/ANALYZE, MATH, MULTIPLY, CH1:R0 A, CH2:R0 B, RESULT R1, SCALE .., START.	MULTIPLY <u>select a proper scale factor</u>
measure with the cursor the TOP of the power-dissipation	CURSOR on R1 MUL, adjust to top, ..	cursor on 'R1 MUL' (answer xx mVV. recalculate the actual power)

OPTIONAL (if one period is selectable with enough resolution) :

-----exercise-----	--knob control--	---- comment -----
measure the dissipation	set: both cursor on the MULT trace select ONE period dX=period time	MEASUREMENTS on the MULT reg trace power =MEAN value energy=MEAN * dX
	select: MEASURE : MEAN & PEAK	(dX= one period !)

QUESTION :

What happens with the displayed traces and the results of the automatic calculations when you change the "VOLTAGE and CURRENT" input signals?
Try to adjust to MINIMUM power dissipation.
Are the measurements and the MULT-trace, automatically updated ?

CONCLUSION :

The measurements of the power dissipation done in the way mentioned above, gives continues updated results. During adjusting the circuits concerning these measurements these updated values give direct information on the changes made.

EXERCISE 2 :

-----exercise-----	--knob control--	---- comment -----
Integrate the MULT register over ONE period to get the energy consumption trace	select INTEGRATE cursor limit for one period	CURSOR LIMIT INTEGRATE

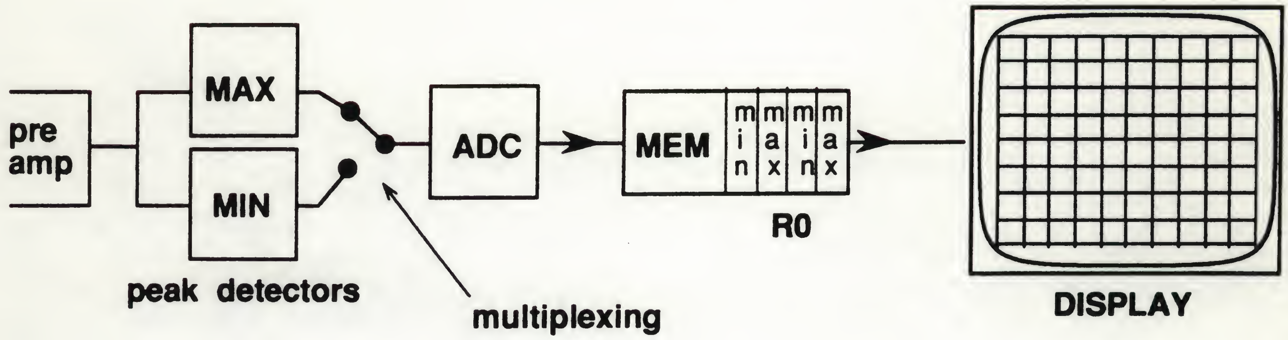
NOTE : Switching on a new MATH-function (INTEGRATE) will automatically switch off the foregoing MATH-function (MULTIPLY)!

MIN/MAX MODE

continues information
between the sample moments

MIN/MAX MODE

voor invangen belangrijke info over 2 sample's .

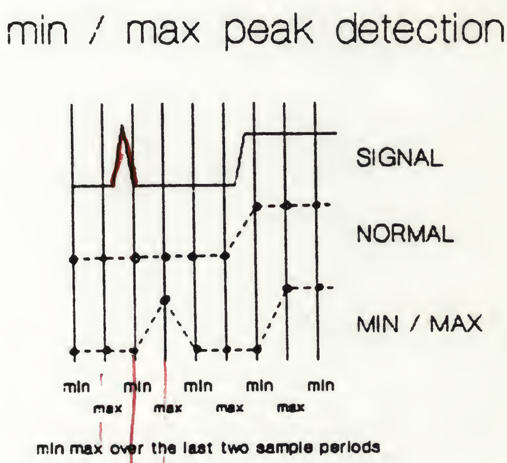


MIN/MAX MODE

In this vertical processing mode the maximum and minimum signal amplitudes over the time BETWEEN two adjacent input signal samples are measured by two PEAK detectors. These minimum and maximum signal levels are alternatively applied in series to the acquisition channel. This results in a acquisition memory filled with alternate MIN and MAX samples. One sweep consists of 256 MAX and 256 MIN samples.

Due to the time needed for RESET of the peak detectors (20 usec), time-base setting above 5 usec/div result in a 'blind time' of the detectors above 10%.

The MIN/MAX mode can be selected for:
- GLITCH DETECTION,
- envelope measurements and
- aliasing detection.



min 1e 2 sample's

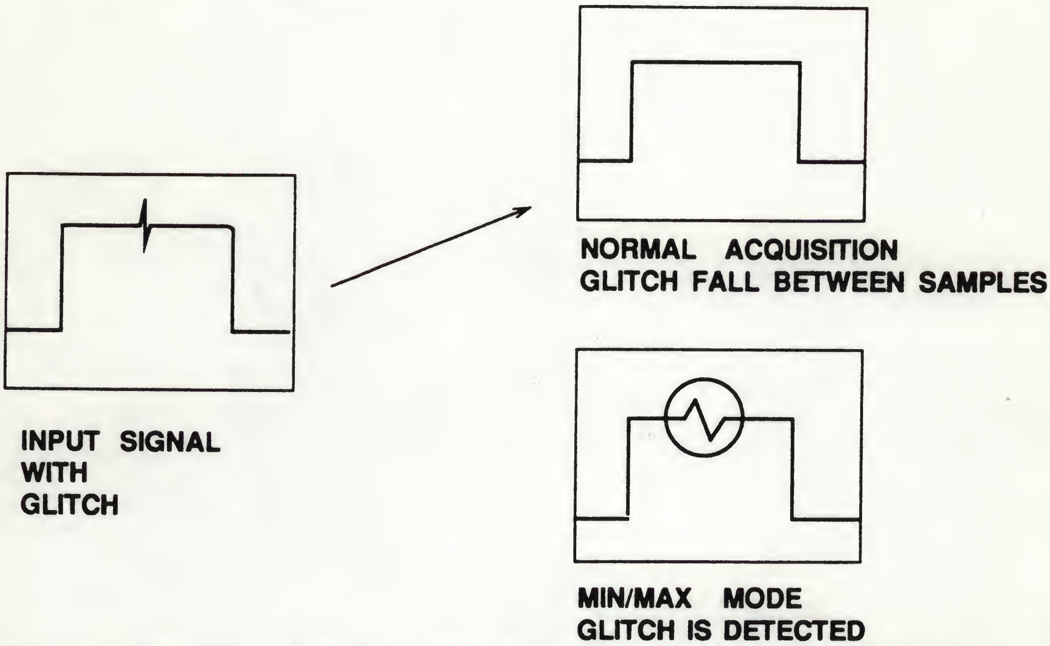
max voorgaande 2 sample's

als piekdetector zo snel moet worden dat deze niet meer betrouwbaar is → min/max mode valt uit menu .

informatie is wel verschoven .

Glitches worden dus gedetecteerd .

GLITCH DETECTION



Glitch detection

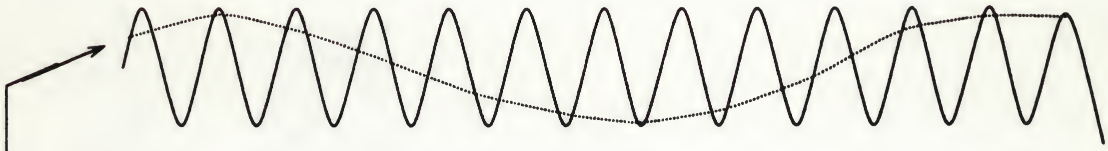
By means of the MIN/MAX mode, every glitch with a pulse width of at least 3 nsec hidden in a lower frequency signal can be DETECTED. Its position in the low-frequency signal is made visible by an interruption of the trace.

Switching to a faster time-base and if necessary to a related trigger delay, the glitch can be captured with 100 psec resolution and built up with a 30 samples.

Reset time of the peak detectors. If a glitch occurs in the reset time of a peak detector it is not seen. Glitches longer than 20 nsec are always seen. The amplitudes depend on the part of the glitch that is outside the reset time of the peak detector.

The chances of catching a glitch are reduced if a LOWER time-base frequency is selected.

DETECTION OF ALIASING



**input signal, sampled with a TO LOW sample rate gives:
a aliased signal in the acquisition memory**

**MIN/MAX
detects every
min/max peak of
the original signal**

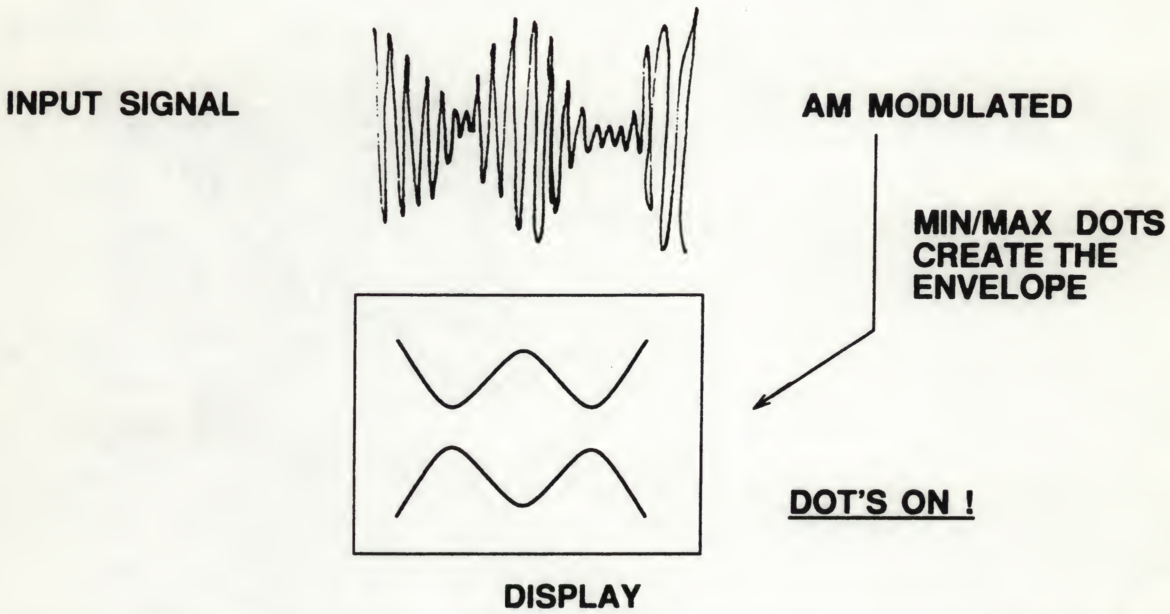
Detection of the Aliasing

As discussed in Chapter "Under-sampling and Aliasing Errors" , input signals sampled with a sample rate much lower than the input signal frequency can cause ALIASING.

Usually this is indicated by the ALIASING pilot lamp. Sometimes aliasing might still occur, but is NOT indicated. For example, an AM signal captured with an external triggering on the LF component. To determine if the displayed signal is correct, the MIN/MAX mode can be selected. If the envelope of the input signal is now displayed; there was ALIASING !

Aliasing errors can be reduced by selecting as fast a time-base setting as possible.

ENVELOPE MEASUREMENT



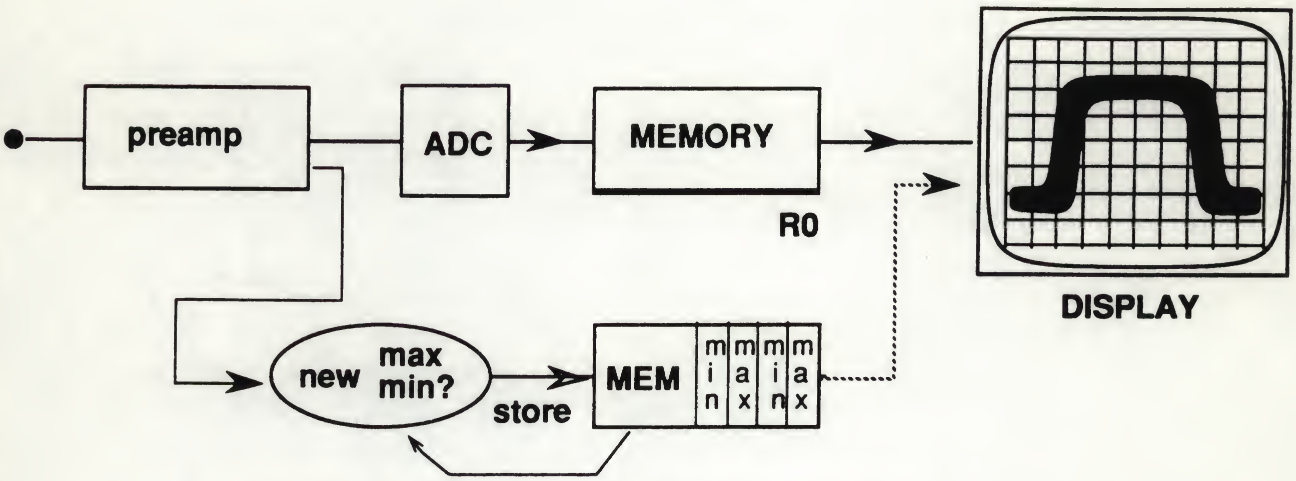
Envelope measurements

Because of the measuring of the minimum and maximum value of a input signal BETWEEN two adjacent samples, the MIN/MAX mode is perfectly suitable for measuring and displaying the ENVELOPE of an AMPLITUDE MODULATED r.f. signal.

ENVELOPE MODE
is ABSOLUTE MIN/MAX mode

jitter measurements

ABSOLUTE MIN/MAX



function like : envelope / infinite persistance
capture All the MAX and MIN between start and stop

ABSOLUTE MIN/MAX

Absolute MIN/MAX mode is a kind of envelope or infinity persistance mode.

This mode records the maximum and minimum variations of each sample of the incoming signal and store them in a user selected register. This MIN/MAX register will be alternately filled with MIN and MAX values (256 MIN and 256 MAX). After each new acquisition new MIN and MAX values, if they occur, will be filled in the register. The result is a envelope of all the MIN and MAX values that ever occur.

MIN/MAX can be used for capturing:
- short and long-term drift
- signal jitter and abberations
- modulation
- noise, etc

This mode slows down ALL the other functions of the 'scope due to a consumption of a large amount of processing time of the main microprocessor.

Automatic pulse jitter measurement

Suppose there is a positive pulse with variable pulse width. You want to measure the amount of jitter on the falling edge. This can be done fully automatic, independent of the signal amplitude.

We can build an envelope of the jitter over time, being the area where the pulse spreads, and measure the time between the first and the last falling edge found, crossing the 50% levels.

Select the positive trigger slope.Set the timebase and the trigger delay in order to display only the falling edge and to give room to the (expected) amount of jitter. The delay must be at least one division, in order to have the rising edge off the display. Make sure no positive transition is visible on either side of the screen.

Select DISPLAY-menu, REG. SELECT, R0 ON, R1 ON.

Make an envelope of the jitter in register 1: select VERTICAL MODE, PROCESSING, ABS. MINMAX, START.

Make sure the result register is R1 (default). Don't use the AUTO ERASE possibility.

Select the CURSOR/ANALYZE-menu, CURSORS SELECT, ON + or ON X, 1st R0-A, R1 A, AMP (not the TIME mode), AMP MODE , REF 0% = PROB. LOW.MORE (100%), REF 100% = PROB. HIGH, RETURN.

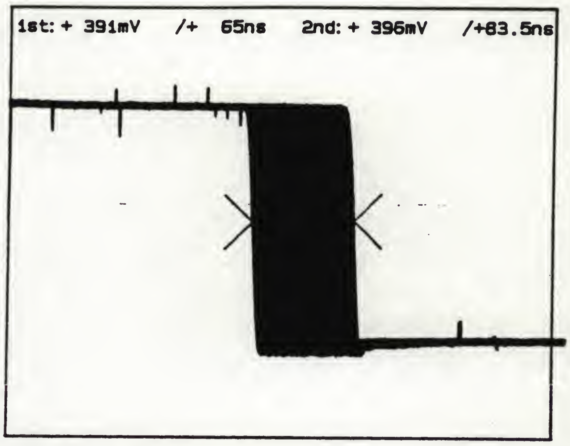


Figure 8. Jitter measurement .

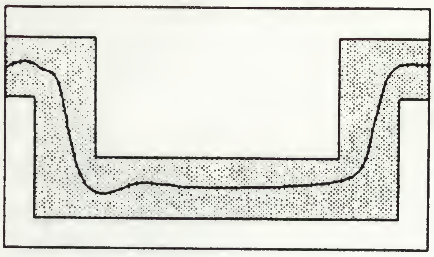
```
COMMAND STRING
spl cursor
cur type_2
cur volt
first_cursor r1
second_cursor r1
for first_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
first 2049
search left
search 1
for second_cursor
mod relative
for ref_0
reference prob_low
for ref_100
reference prob_high
second 2049
search right
search 1
```

Turn the rotary for control of the first cursor position until the central reading in the softkey text area is at + 50% . Have the system to search for the first occurrence of the 50% level from the left side of the screen: SEARCH 1-->, RETURN.
Select the reference levels and the positioning for the second cursor: MORE (2nd), CURSOR 2nd at R1 A, AMP. MODE , REF. AS 1st.

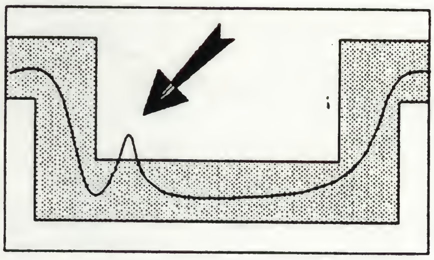
STOP / SAVE on DIFFERENCE

capture signals running
outside a REFERENCE

Stop on difference



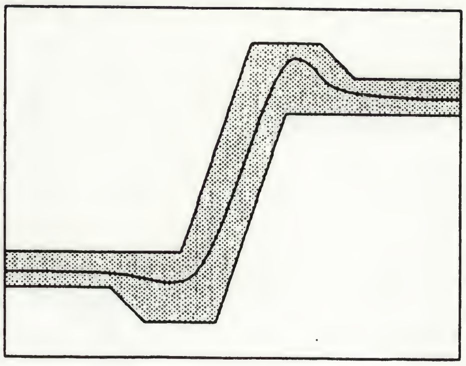
RUNNING



STOP

catch a glitch!

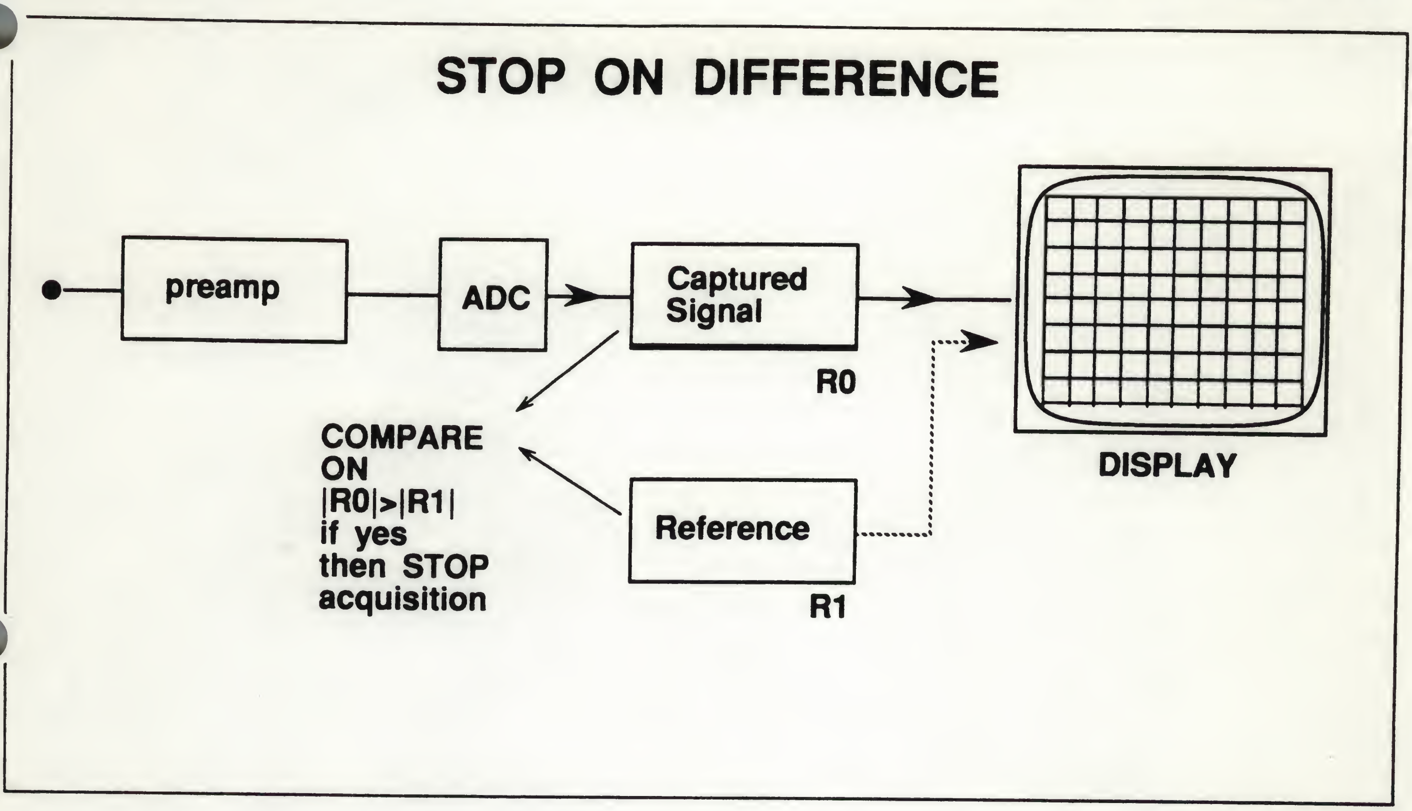
Production control



Testing the shape of an edge.

Applications:

- adjust duty cycle
- compare a "good" board with an "error" board
- adjust/control jitter
- check overshoots

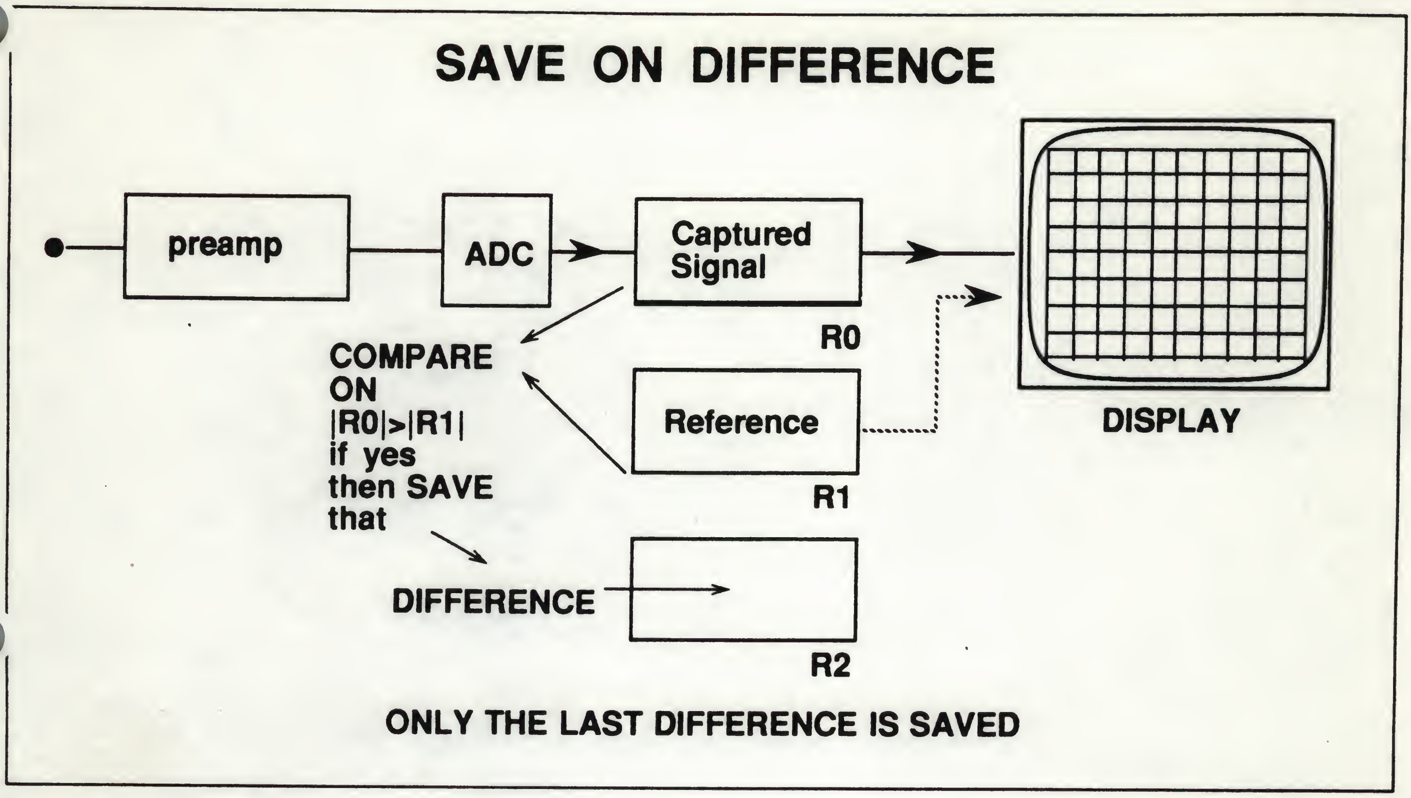


HORIZONTAL PROCESSING

STOP ON DIFFERENCE

'Stop on difference' stops the acquisition of new input signals if it detects an acquired sample that has a value outside the boundaries of a REFERENCE envelope. The last acquired trace is stored in the register R0 together with a time stamp, for later examination.

This mode is very suitable for :
- production control
- fault finding in continuous testing



SAVE ON DIFFERENCE

'Save on difference' saves the last captured input signal that differs from a reference stored in another register, in a user selected register. It continues the acquisition until the next difference occurs. Together with a time and data stamp, only the LAST difference is SAVED.

The REFERENCE can be :
- the result of an 'absolute MIN/MAX mode' envelope
- created by the operator, from the front panel
- or down-loaded from a remote device via REMOTE control.

INTERMITTENT FAULTS / GLITCH DETECTION

APPLICATION AREA think of:

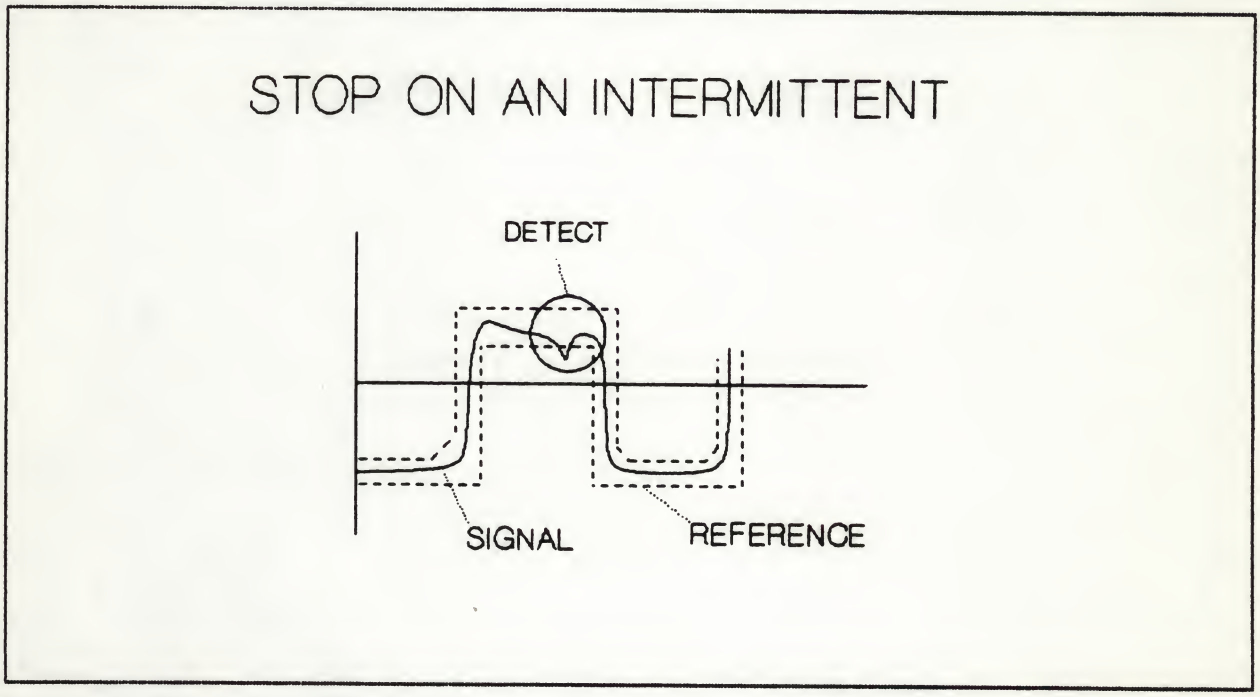
Trouble shooting on intermittent faults can be found in any industry where you are looking at outside influences (cross talk, magnetic pick-up, spikes,..) on the electronic circuits. So any place in R&D, SERVICE and PRODUCTION.

INTRODUCTION:

SEE application note PM3320A no 1 : "Drift and intermittent faults captured using the PM3320A" page 3 and 4.

Isolating a fault like a 'glitch' can be done easily by a 'Stop on difference' to a referenced Envelope.

This envelope can be created by the **MENU** selections on the front panel, or via the ABSOLUTE MIN/MAX mode, or downloaded from a GPIB (IEEE-488) controller

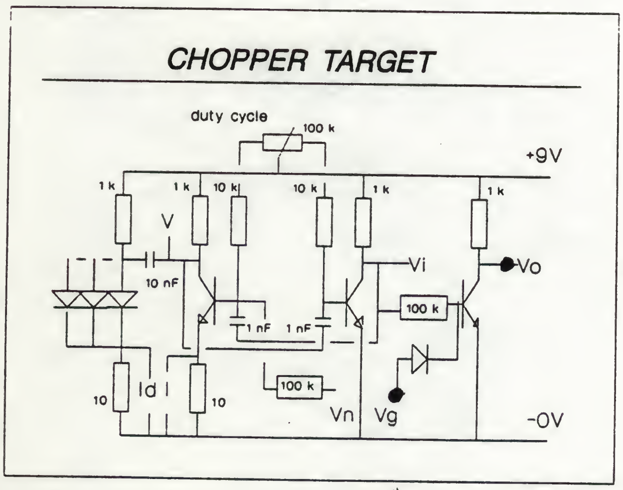


EXERCISE:

-----exercise-----	--knob control--	---- comment -----
Create an envelope (in register R2) using a stable source square wave signal.	DISPLAY, REG SELECT, R0,R2, ON.	R0 acquisition
	TRIGGER DELAY, up to 1div, no events	Attention don't use a signal starting with a vertical line!
	HORIZONTAL MODE, DIFFERENCE>, [off, SAVE:Rx>, R1, return] REFERENCE>, R2, RESTORE, adjust gap: up/down, amp/time return.	R2 envelope restore R1 to R2 and create envelope.
capture a glitch (create one during run by connecting a triangle signal on the Vg input of the target, 20kHz +- 2.1 Vpp)	VERTICAL MODE to MIN/MAX !, DIFFERENCE MODE to STOP, and START.	MIN/MAX ON if this glitch is very small! wait until acquisition stops due to a glitch

CONCLUSION :

This mode offers a continues BABYSIT on glitches which can come after hours.



square wave output with "glitch"

20 kHz , 2.1 Vpp

PHILIPS

Drift and intermittent faults captured using the PM3320A

Ever had the problem where you're looking for voltage or time drift but it only changes a little over the day. Sure, you don't mind sitting in front of a scope to watch it, but for 8 hours!
What about those intermittants, everything's fine while you're there but as soon as you turn your back, POW!: Complete system failure.

Wouldn't it be great if someone comes up with a simple yet flexible way to capture these kind of faults automatically. A method that frees you from the eyestrain and tedious hours of screen watching. A method that gives you eyes in the back of your head when you're not looking.

That method is already here, it's just a part of the many sophisticated capture capabilities of the **PM 3320 A** digital storage oscilloscope.
And what's more the method is easy to implement due to the ergonomic control and selection structures built into the instrument.

Let's take a look at the drift problem. The easiest way to view drift is to build up an historical record of the variations , this results in an "envelope" of the time and voltage changes over the period of measurement whether it's a few seconds or many hours. In the **PM 3320 A** this function is known as absolute **Min/Max.**

Simply described; on each acquisition or sweep of the signal a comparison is made of the digitised waveform and a previously stored "envelope". If the variation at any sample point is greater than the previous maximum then if becomes the new maximum and if any sample point is lower than the minimum at that point it then becomes the new minimum. This acquiring and comparing occurs continuously with the result being the envelope of the signal variations over time. An example of this can be seen in *fig. 1.* The signal is sitting inside the maximum/minimum envelope which has suffered on offset drift and variations in the rising edge of the pulse. This could cause incorrect timing in down stream circuitry, with absolute **Min/Max** the problem is quickly verified.

Once you have the envelope it's then very easy to read off the spread of the signal, just place cursors on the displayed trace and take the measurement.

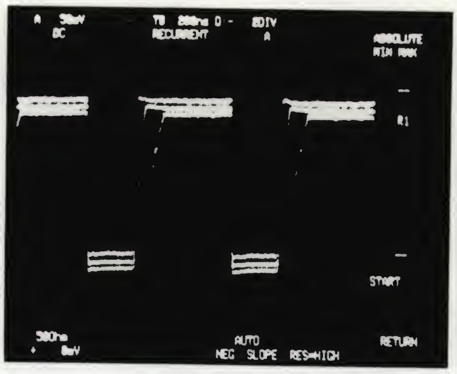


fig.1

But what about the other problem, that of intermittants.

An approach to this problem could be to compare an incoming signal against a known reference signal.

By halting acquisition as soon as a difference occurs, you are then highlighting the reason why your system or circuitry failed.

Usually however, there will be a certain limit to which the system is tolerant and inside this limit the signal is correct. It is then better to compare the incoming signal against a limit envelope and halt acquisition when the signal is outside this envelope reference in time or amplitude. An example of such a reference envelope is given in *fig. 2.*

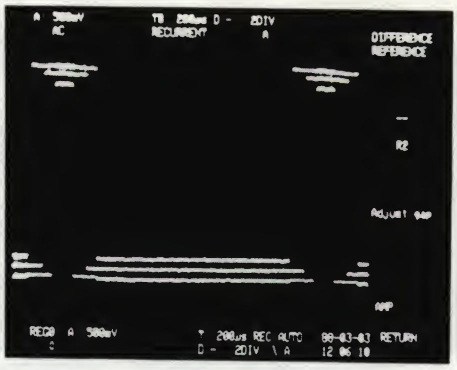


fig. 2

Here a fault is isolated by confirmation that a "glitch" is occurring and with the **PM 3320 A** that glitch can be captured down to 3 ns spikes using the peak detection function. The system could see this as a valid edge and causes misinterpretation of the data. Capturing in this way is known as the **"Stop on Difference"** mode in the **PM 3320 A**. When the difference is detected the signal is also time stamped (right hand bottom corner of *fig. 2*) to indicate when the fault occurred. This time-stamping may help in pointing to possible outside influences on your circuitry; for example if a heavy electric motor is started up at a certain time during the day then the resulting induced fields could be the cause of the problem, the time stamp may help to verify this.

Let's go back to our first problem, where we saw voltage and time variations. This too can be analyzed using the stop on difference facilities of the **PM 3320 A.**
Suppose we were able to specify the limits of allowable drift. We could then construct our reference envelope to incorporate these limits and test to see if the signal exceeded them over the measuring period. The instrument simply "babysits" the comparison and captures the excursion outside the reference and again time-stamps when the difference was detected. This could indeed be used in production, in service and even in development where you may be looking at variations due to temperature and verifying your design.

So how do you construct your test reference envelope. There are three ways to achieve this in the **PM 3320 A** :

- Use the envelope created by the absolute **Min/Max** acquisition.
- Create the reference envelope using simple menu selections on the front panel.
- Download via the IEEE-488 or RS-232 interface a reference envelope constructed of data points generated by a computer program.

By taking your known good signal which you consider to be at the limits of desired operation you can capture the amplitude and time variations by building up the envelope using the instruments absolute **Min/Max** function. This envelope is then the reference against which all further tests are made, a very simple way to make circuit to circuit comparisons in which you can monitor all differences and reject the units that are out of limits.

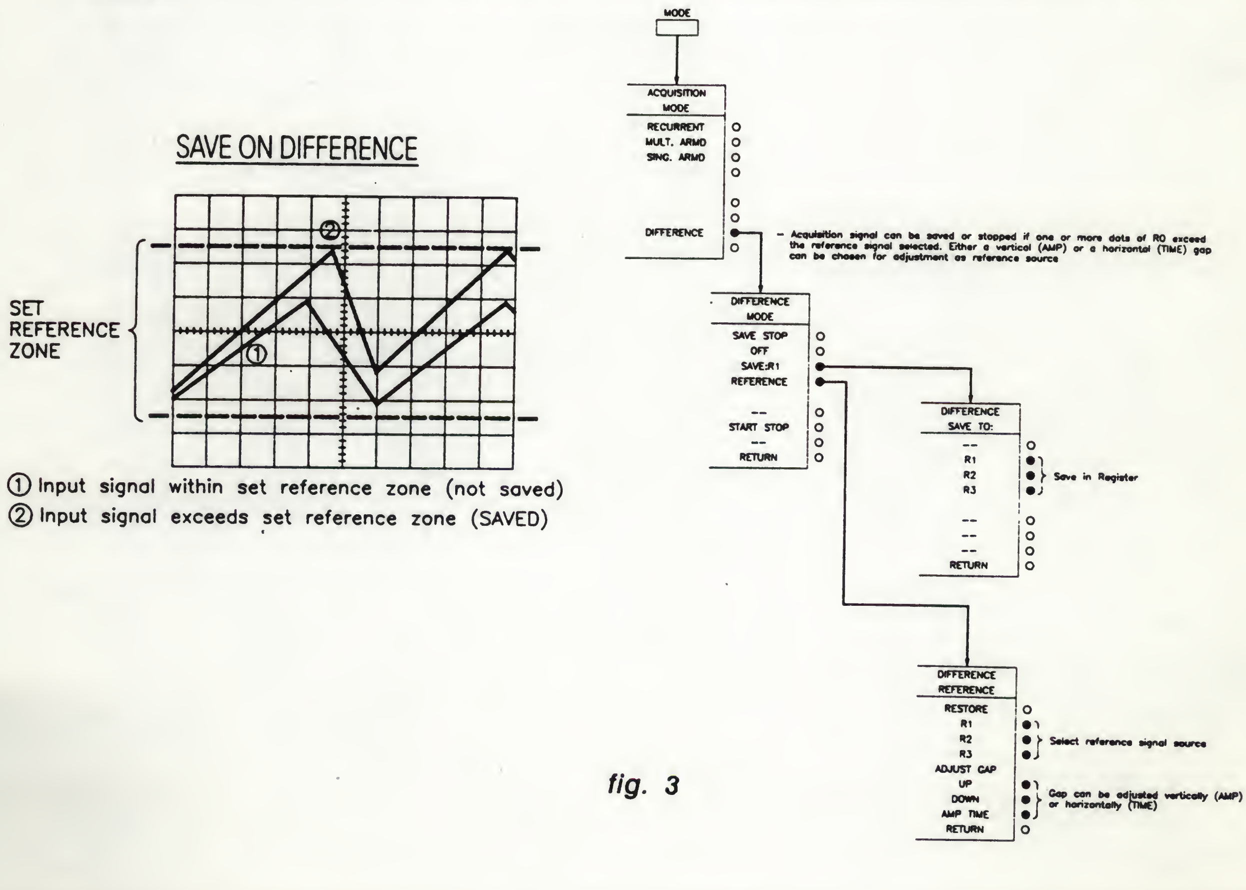


fig. 3

Creating the reference envelope from the front panel is just as easy. By taking your signal and copying it to a reference register or memory you than have the basis for comparison. A menu selection named DIFFERENCE REFERENCE (see right hand side of *fig. 2*) allows you to build up a reference envelope by adjusting the amplitude and time variation from you base reference signal. Simply key-in "Up" or "Down" to adjust the TIME or AMPlitude gap. Once you are satisfied you have the correct envelope this can then be used for the stop on difference comparison. The complete set up sequence and menu selection for this application is shown in *fig. 3*.

The third way to construct the reference envelope is to program a "template" in a computer and download this template to the instrument via the IEEE-488 or RS-232 interface. The template could be used for automatic testing in production, reducing time and cost per test. For example in the testing of disk drives (*fig.4*), for out of limits comparison against T1 carrier pulse templates in telecommunication conformance tests (*fig. 5*), for functional test and adjustment of many circuits in production. The applications are wide but the use of the stop on difference adds up to faster and more productive circuit test.

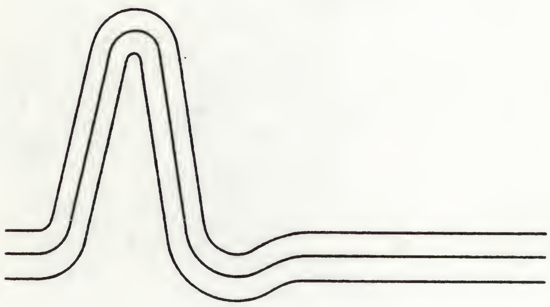


fig.4

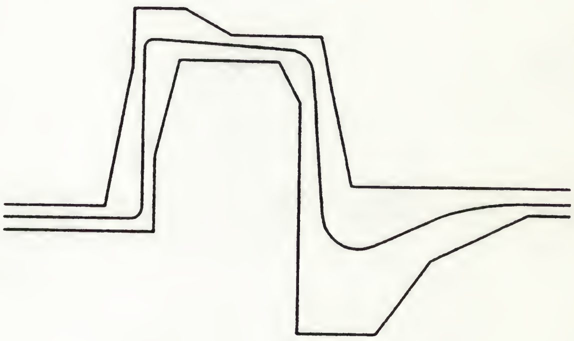


fig.5

Extending the automatic comparison facility even further is the **"Save on Difference"** mode.
It could be that you wish to test when a signal goes "inside" certain limits rather than out of limits. This is possible with the save on difference facility. It works by overwriting a memory register while the signal is outside the reference envelope; and as soon as the signal enters the area between the limits this overwriting stops.
That means that you always capture the last signal before it's within the limits and of course it's also time stamped.
This can be used to verify that the circuitry returns to it's normal operating conditions after for example an overload of the input or a short circuit of the output.

This note highlights just a small part of the **PM 3320 A** capture and analysis capabilities. For more information contact your local **Fluke/Philips** sales and service office.

COUNTING ON EVENTS

extend the PRE / POST TRIGGER delay

far away from the triggerpiont

COUNTING ON EVENTS

ACQUISITION DELAY BY EVENT-COUNTER AND PRE/POST TRIGGER

```
      signal ->                                              -->time
   eXtXXXXeXXXXXXXXXXeXXXXeXXXXXXXXXXeXXXXeXXXXeXXXXeXXXXeXeXXXX
      |<-------------------------------------------------->|
      |                          |                   |<----------->|
      |                          |                   |             |
      trigger-            eventcounter               pre      post |
      point                :                         'trigger'-delay
      :                    :                         |-------------|
      set by:              set by:                   set by:       |
      triggersource,       source (input),           number of     |
      triggerlevel,        level,                    div/screen/time
      slope.               slope,                                  |
                           number of events                        |
                            to be count.                           start
                                                                   of
                                                                   acqui-
                                                                   sition
```

EVENT COUNTING :

The start of an acquisition can be delayed until a certain number of edges crossing a certain voltage level on the event counter is counted. The effect is a ADDITIONAL DELAY TIME. Here after the acquisition can be modified by the normal trigger delay (pre and post triggering).

Na x events: start acquisitie.

eventcounting → aansluiten BNC Events /EXT

↑

CLOCK

TRIGGER

↓

aantal events

↓

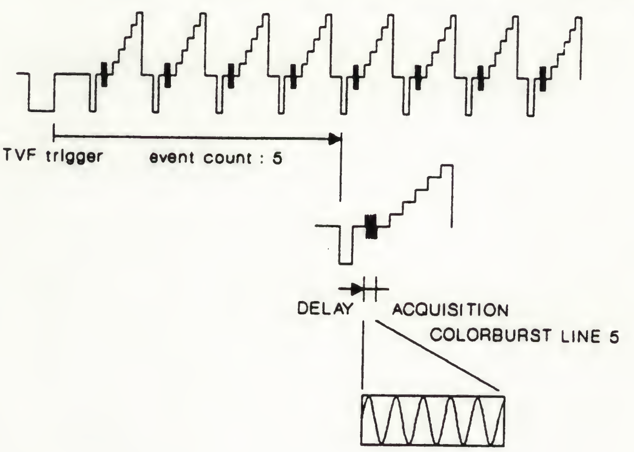
normal delay

↓

start acquisition.

EXERCISE :

EVENT counting in TV signal



-----exercise-----	--knob control--	---- comment -----
measure the colour burst frequency of the 23th line, set the video generator to 'grey scale'	TRIGGER-COUPLING, TVF, slope +, ev/ext clk>, slope +, var, LEVEL=0.5v.	TVF
	TRIGGER-DELAY, events>, event+delay, enter>, 28,(348) execute, return,	DELAY on EVENTS setup level of events and number of events
	(pre/post trig) up,(-1div)	PRE and POST TRIGGERING
	(adjust Time/div, and post trig, measure FREQ)	set HORZ mode to 'max.resol' off! lock acquisition

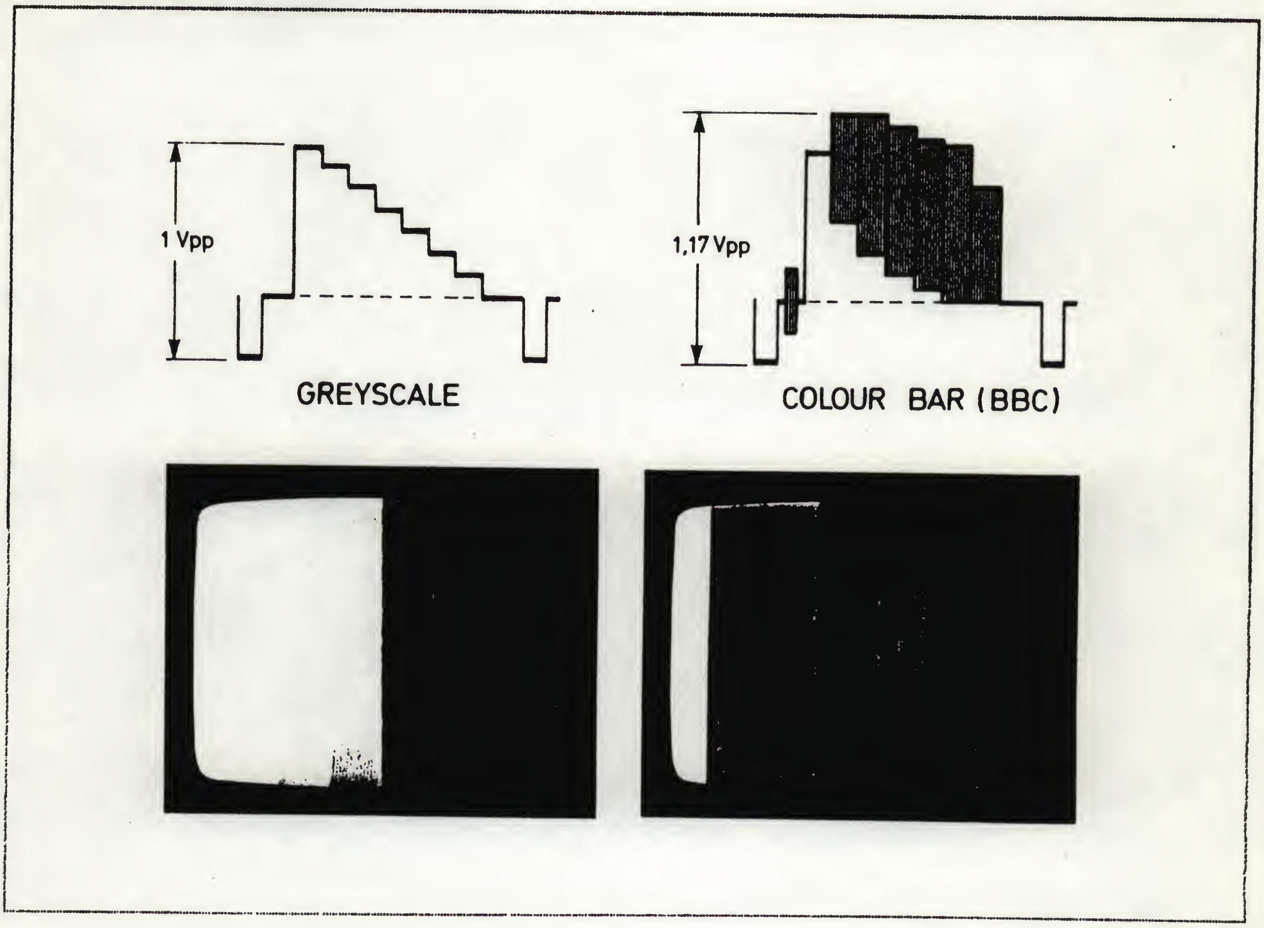
QUESTION :

Is the video line on the 348 and 28 event the same ?
Are there realistic measurement to do with the DELAY on EVENTS function in microcomputer circuits ?

CONCLUSION :

DELAY on EVENTS can give full resolution on every video line even after seconds of delay.
In general repetitive signals running under control of a synchrone signal (like the clock, a 'chip select',etc in a microcomputer system) can be examined under full resolution after counting up to 10,000 events of that synchrone signal.

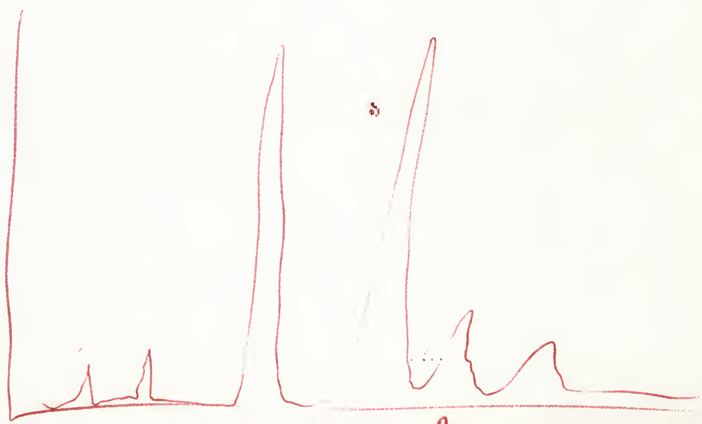
video oscillograms :



WAVEFORM CHARACTERISTICS

RMS and FFT from live signal

FFT → freq. spectrum van puls.



bij foutzoeken interessant bv. overspraak.

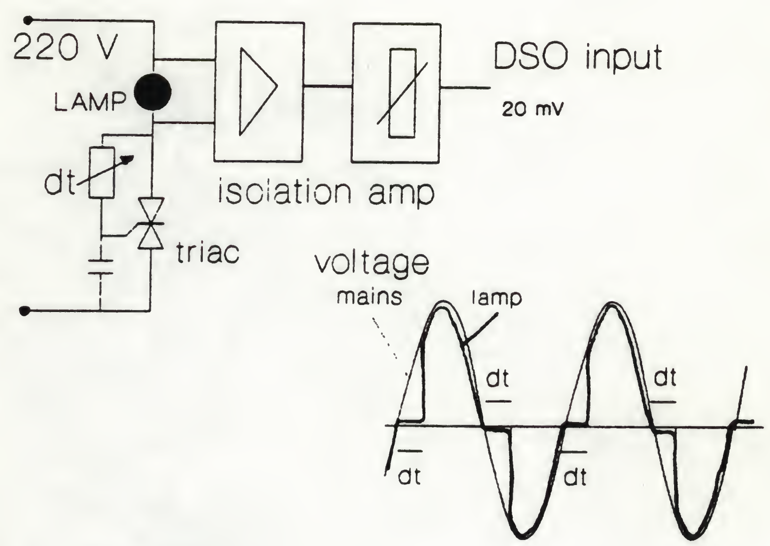
LIGHT DIMMER / WAVEFORM CHARACTERISTICS

APPLICATION AREA think of:

Motor control industry , POWER (FET) switching.

INTRODUCTION:

How does a TRIAC control work ?

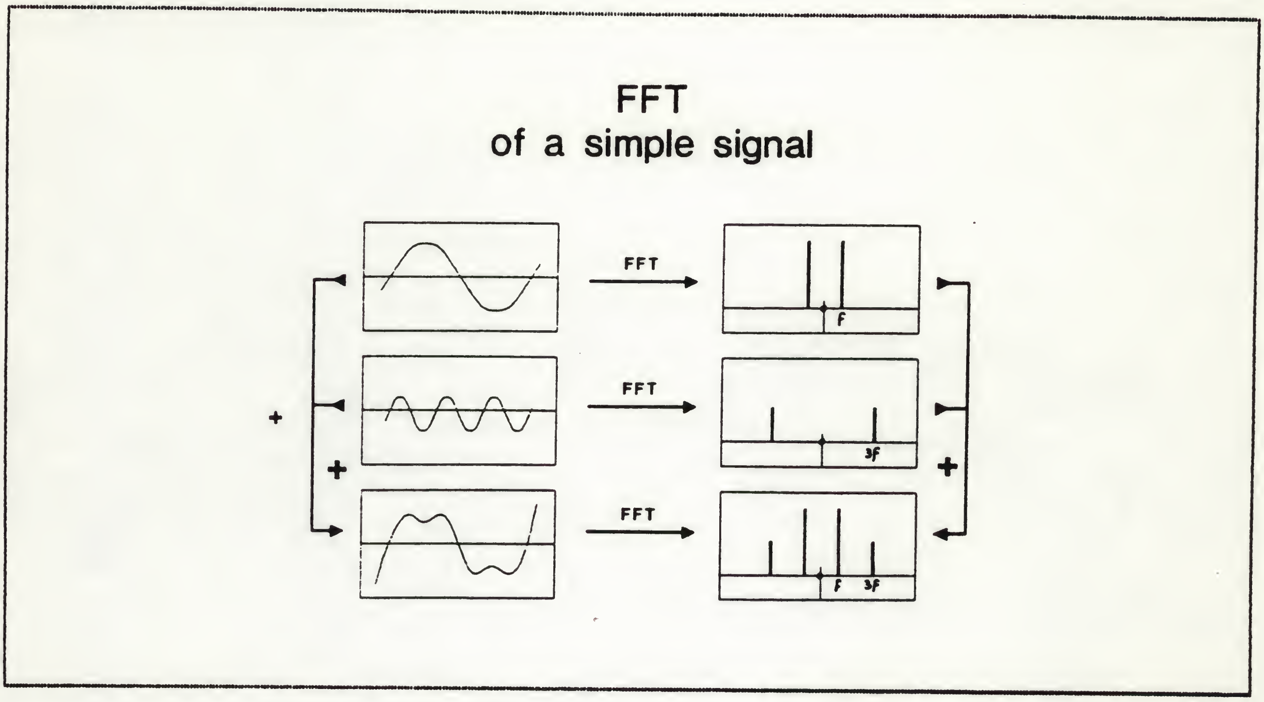


By cutting the waveform, switching circuits can economically control, power consuming devices like motors and solenoids. The loss of power in the switching devices is reduced to the moments they turn on or off. These switching can create some unwanted frequency components.

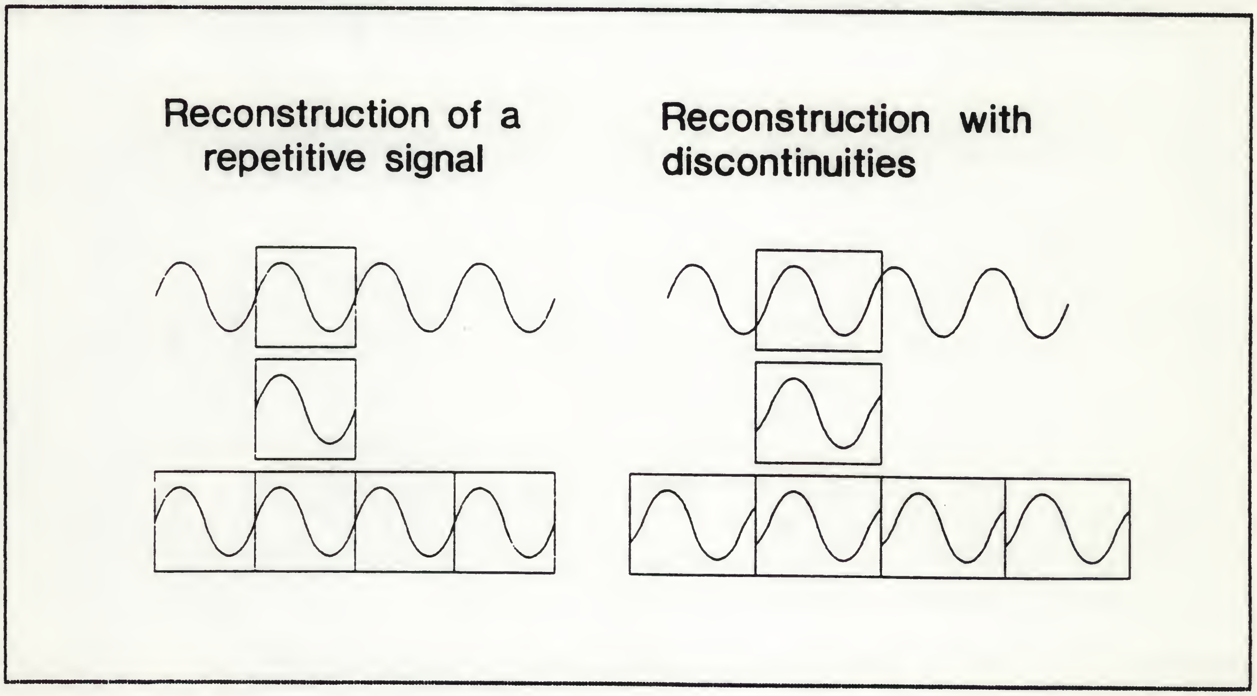
Useful measurements are

1) The RMS-value of the power transferred to the controlled device.
2) The unwanted frequency components (FFT) created by cutting the waveform, especially when they could create crosstalk to other circuits.

INTRODUCTION on FFT:

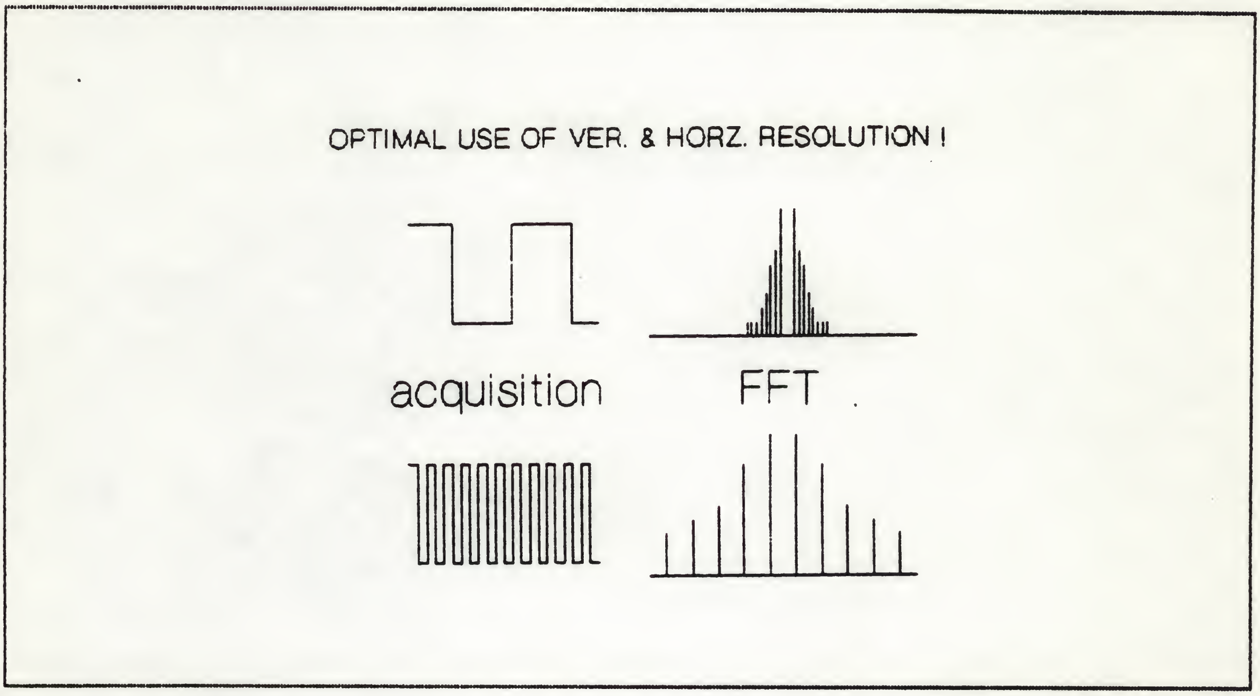


FFT stands for FAST FOURIER TRANSFORMATION. This MATHEMATICAL option calculates out off the captured waveform the according frequency spectrum. The result in a diagram where the different frequency components with there amplitude values are drawed.



For calculating a FFT a continues signal information is needed. In a DSO however a time record is acquired and stored in a memory. To reconstruct the original signal the FFT software assumes that this time record can be enlarged by itself. So attention had to be given

to the boundaries of this record. If they create discontinuities, they had to be adjust. Adjusting can be done by the use of cursor-limited-FFT or by filtering with build-in filters (Hamming & Hanning).



OPTIMAL USE OF VERTICAL & HORIZONTAL RESOLUTION gives a BETTER FFT SPECTRUM OUTPUT

VERTICAL resolution:
The accuracy of the FFT response is limited to the vertical resolution of the acquisition. An optimal use of the vertical resolution is a MUST!

HORIZONTAL resolution:
The more periods are acquired by the acquisition of the DSO, the more frequency information is captured and displayed in the FFT output. But be aware of capturing to much periods, because of the limited horizontal definition (4096/512 point) of the acquisition system of the DSO.

EXERCISE : RMS

-----exercise-----	--knob control--	---- comment -----
display the lamp voltage at full and half bright :	connect up, AUTOSET,	*
To save energy of the batteries of the Isolation amplifier, make shots of the lamp voltages and SAVE them to the MEMORIES R1 and R2.	SAVE/PLOT, save to Rx	*
perform a RMS on the saved measurement.	DISPLAY, reg select>, Rx ON/OFF, CURSOR, ON, measure, amplitude, RMS, return, set CURSOR, (period !) (incl offset ?!)	measurements RMS on stored waveforms

CONCLUSION :

Is the result displayed the TRUE RMS value ?
What is the bandwidth limit of this measurement ?
compare this with a multimeter RMS function, like in the FLUKE 77!

FFT measurements :

THINK ABOUT :

vertical settings (resolution and accuracy)
number of periods captured (one, more, crowded ?)
choose calculating windows : RECTANG/HAMMING/HANNING
or cursor LIMIT

EXERCISE : FFT on a sinewave

-----exercise-----	--knob control--	---- comment -----
supply a pure sine wave to the input of the DSO and perform a FFT measurement	AUTOSET, DISPLAY, reg select, R0 on,R1 on, (clear R1) CURSOR, ON, mathematics,more, ---------------- FFT, CH: R0 A >, RESULT: R1>, FFT PARAM>, rectang, lin(v), return, cursor lmt OFF, start. -----------------	FFT ATTENTION SETUP: window, cursor limit number of captured periods discontinuities

Note : ATTENTION to the MENU structure of a MATH function !

examination of FFT: measure the results in CH R1	MAGNIFY, expand,(repeat), CURSOR, ON, 1st: R1 FFT>, 2nd: R1 FFT>, position cursor on FFT trace, read volt/freq.	ATTENTION : 'stop' FFT when doing a FFT on cursor limit (on the source trace R0)

QUESTIONS :

How does the FFT spectrum output look like when using a calculating window which creates <u>discontinuities ?</u>
Try to correct this with CURSOR LIMITS.
Does the FFT curves look better ?
Now switch off the cursor-limit and try to make corrections with the HAMMING and MANNING filters.
Which of the methods is the nice one ?

When using a sinewave input, for calculating a FFT, what is the amplitude value of this sinewave frequency component in the FFT spectrum in relation to the original signal amplitude ?
Switch over to a pure squarewave of the same frequency. Is the FFT curve to your expectations?

EXERCISE FFT , continue :

-----exercise-----	--knob control--	---- comment -----
Perform a FFT on the stored waveform : 'lamp at half bright'	Display according Register. Be aware of discontinuities!!	*

QUESTIONS :

Are there other frequency components than the original supply voltage frequency?
Change the brightness of the lamp, capture an acquisition (in MEMORY to save the energy of the battery) and look for the maximum of unwanted frequency components in the FFT spectrum!
Could these frequencies give crosstalk to other sensible electronic circuits ?

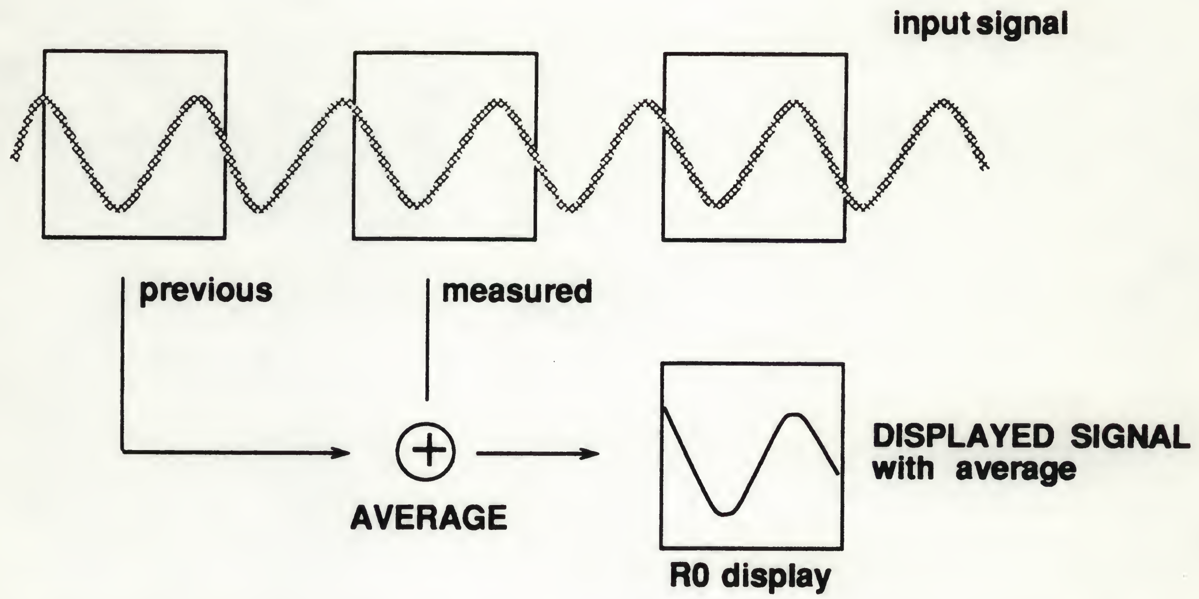
CONCLUSION :

The FFT MATH function is not a REPLACEMENT of a Spectrum Analyzer, it's a powerful QUICK CHECK which can give you a first glance of the frequency components <u>dominating your signal.</u>

AVERAGE MODE

clean-up your signal

AVERAGE MODE



VERTICAL PROCESSING

AVERAGING MODE

Averaging is a method of suppressing noise without losing bandwidth and can only be used for repetitive signals (recurrent time-base modes). In this mode, every new sample stored and displayed is calculated in respect to the previous sample, at the same position, and with a weight factor in the following way:

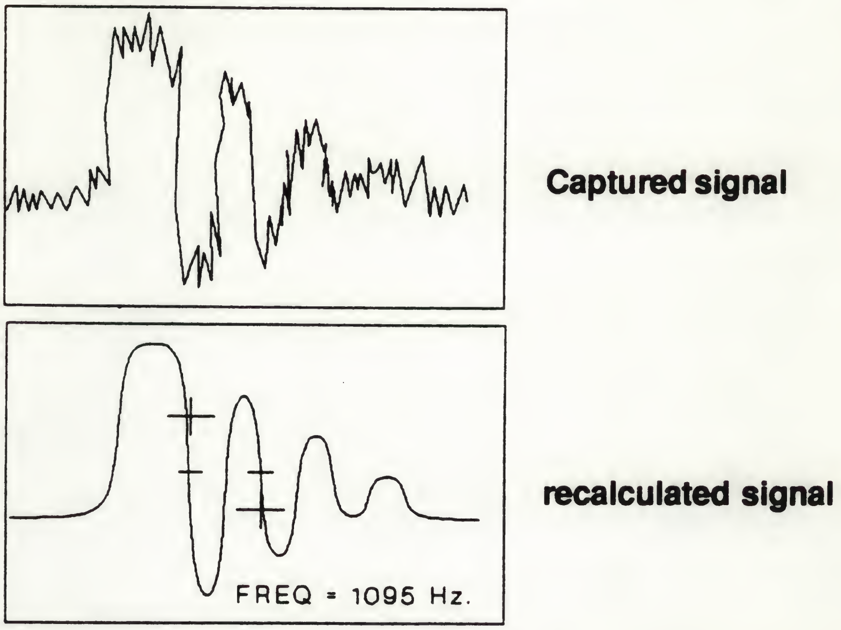
$$\text{new} = \text{previous} + \frac{\text{measured} - \text{previous}}{\text{weight factor (C)}}$$

With the AVERAGE mode on: C > 1 , the new stored sample changes slower with respect to uncertain signal components such as NOISE.

AVERAGE leads to:
- more accurate measuring of the signal waveform and
- stable readout of the cursor-related measurements.

MISCELLANEOUS

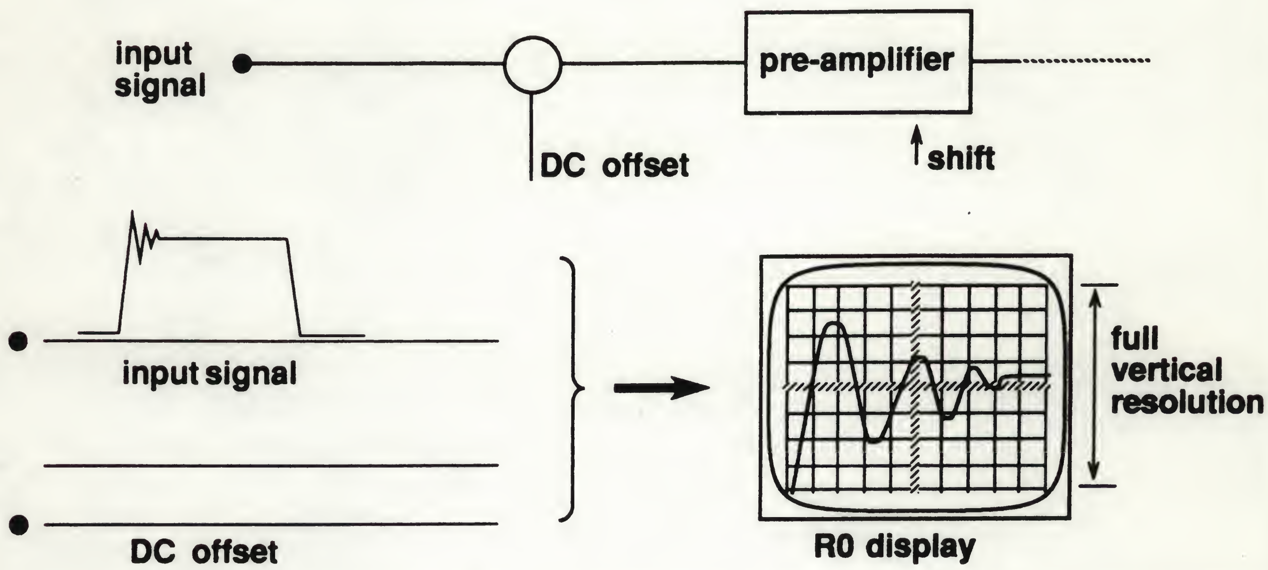
FILTER FUNCTION



FILTER FUNCTION AGAINST AVERAGE MODE

Average mode is very powerful but can ONLY be used for REPETITIVE signals. The Filter function allows filtering AFTER the (one) acquisition is made. This mathematical function can filter out uncertain signal components, such as noise, by means of recalculation of the samples stored.

OFFSET AND VERTICAL RESOLUTION

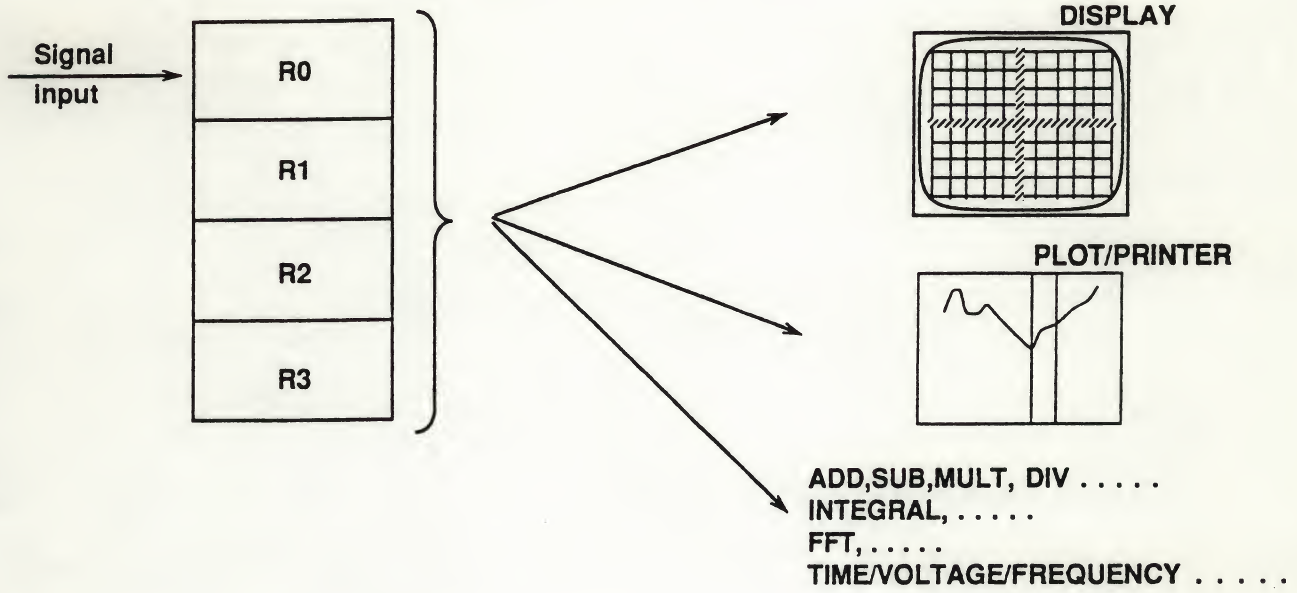


VERTICAL INPUT

OFFSET AND VERTICAL RESOLUTION

The vertical offset adjustment is located in the front circuit of the vertical input amplifier. It appears to act like a vertical shift; however, problems of over-ranging the input stages of the input amplifier, as with shift, cannot occur. Using this offset, signal details, such as ringing on a step function, can be freely shifted to around zero level and blown up by the vertical amplifier magnifier. By using the offset in this way, an optimal use of the VERTICAL RESOLUTION of the oscilloscope can be made possible.

DISTRIBUTING ACQUIRED SIGNALS



DISTRIBUTING ACQUIRED SIGNALS

Once a signal is acquired and digitally saved in one of the REGISTERS (R0, R1, R2, R3) it can be send to the DISPLAY, or via interfaces to PRINTERS and PLOTTERS, or to the GPIB (IEEE-488/IEC- 625) controllers 1).

When stored on the display, MEASUREMENTS with TIME and VOLTAGE cursors can be made, and a built-in calculator can perform a wide range of MATHEMATICAL operations on the saved signals.

The MEASUREMENTS and MATHEMATICAL operations are updated every time a new acquisition is completed.

---

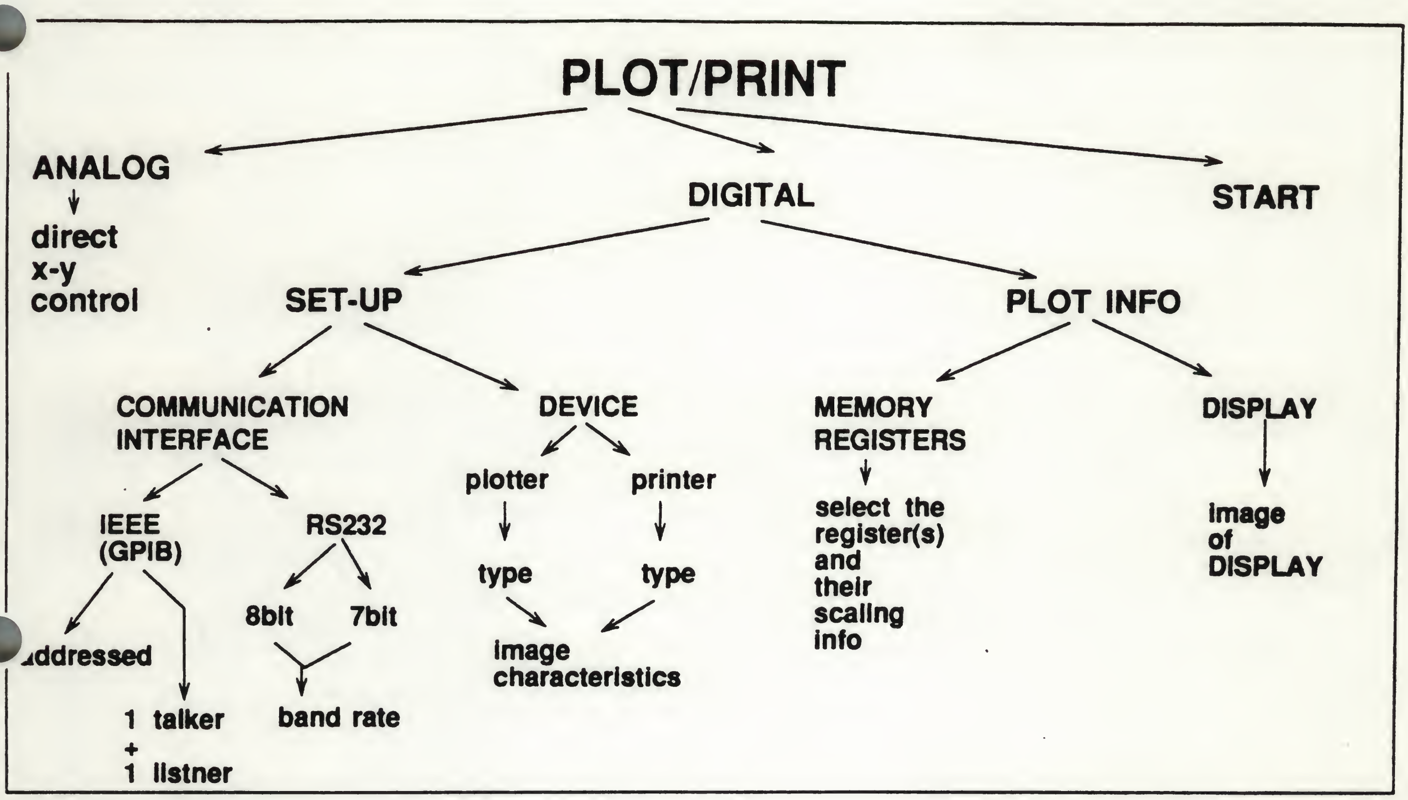
1) The Oscilloscope Signal Processing software package PM2260, running on a PC compatible with GPIB interface, can perform powerful analysis and measurements on the acquired data transferred via the GPIB interface from the DSO.

HARD COPY

DOCUMENTATION / CERTIFICATION

capture all from the CRT

cursors / calculation result etc.



PLOT OR PRINT AN IMAGE

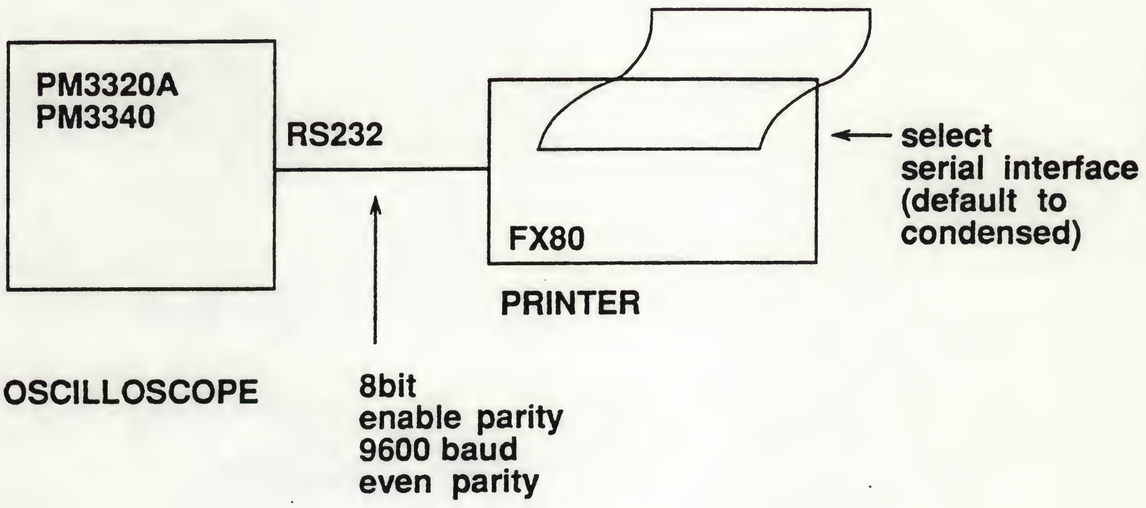
INTRODUCTION

To get a copy of the selected registers or the image of the display on a plotter or printer, first the communication link has to be installed and secondly the device output (image characteristics) has to be chosen.

The foregoing summarises the actions to be taken. On the next pages the related MENUs are shown.

REFERENCES : the Interface - Instruction manual
" PM8956/01 IEEE/RS232 bus interface for PM3320 "

EXAMPLE SET UP: DSO TO PRINTER



EXAMPLE SET-UP : DSO TO PRINTER

The data send to the printer is a combination of GRAPHICS and TEXT data. These modes are controlled by the 'scope microcomputer. To get proper communication, the printer and the oscilloscope interfaces were set to 8 BIT DAT TRANSFER.

Example: for P2908 printer (~FX80)

bit rate	9600 Bd
data word	8 bit
start	1 bit
stop	1 or 2 bits
parity	on , even

DEMO PLOTTING MEMORY AND DISPLAY

INTRODUCTION : SEE APPENDIX serial RS232 or V24.

INSTALLATION OF COMMUNICATION CHANNEL

SELECTION OF PLOTTER/PRINTER

ADJUST POSITION AND MAGNIFY TRACES

'SCREEN' OR MEMORY DUMP

-----exercise-----	--knob control--	---- comment -----
install communication channel to a PLOTTER.	DISPLAY, option, interface, RS232, frame¦ output¦ input	e.q. frame :1 stop, 8 data, NO parity. speed : 9k6, 9k6 baud
install a PLOTTER	SAVE/PLOT, select, Rx, digital>, plot ¦ plotters>, PM8153/6>, size ¦ quadr ¦ grid ¦ RS232	size : 1 quadr :left/bottem grid : all lines
do MEMORY plot	SAVE/PLOT, digital	10x10 div FULL resolution of 10 bit vertical 4096 points horz.
install additional parameters for 'SCREEN-DUMP'	DISPLAY, reg select> (Rx) ¦ full> (Rx) ¦ chan indent	select register(s) on the SCREEN and set there parameters ON/OFF
	DISPLAY, pos Rx ¦ channel> position A ¦ B	position traces on or <u>outside</u> the 'SCREEN'
	DISPLAY-MAGNIFY expand / compress select Y*..	expand the trace
	DOTS on/off	push-button dots
do DISPLAY plot ('SCREEN-DUMP')	DISPLAY, pos Rx, plot, digital	The IMAGE of the tube : 8x10 div

AUTOMATION

FRONTPANEL SETTING
programming and recall

GPIB CONTROL
BINPROG power

APPLICATIONS :
Production Tests
R&D : Repeated TESTS
Curve Adjustment
Signal Shape Adjustment

QUICK SET UP OF FRONT

on front panel		remote via GPIB
FRONTS SAVE	=	BINPROG ?
RECALL		BINPROG <..>
(memory softkey menu)		(read/write Controler)

ALL DSO FUNCTIONS

incl Envelope/Average Modes

incl Cursor position

incl Cursor measurement

incl Calculations

AUTOMATIC MEASUREMENT SYSTEMS / GPIB.

FRONTPANEL SETTING

A tool for semi-automated measurement control.

```
                     PROGRAM FRONT PANEL SETTINGS
 ______________________________________________________________

 SETTING                                          256 1/p mogelijk
 _________________
                              ┌save (at current front no)
 [   ] ──────┬program>──┬─────┼insert (at current front no and
 FRONT NO    │          │     │        shift rest one place)
             ^          │     └delete (current no and shift back
             │          │              rest one place)
             │          ├─────up (change current front no)
             │          ├─────down
             │          ├─────end of seq (finish)
             └return────┤
                        ├─────enter>─┬─X.xx────┬─execute─┐  (new
                        ^            └clear─<──┘         │   number
                        └────────────────────────────────┘   to prog)
```

```
                     EXECUTE FRONT PANEL SETTING
 ______________________________________________________________

 SETTING
 _________________

 [   ] ────────enter>──┬X.xx─────┬──execute─┐  (execute selected)
 FRONT NO              ├clear─<──┘          │
                       ├───────────<────────┘
                       ├recall      (execute current front no)
                       │
                       ├next ....┐
                       ├previous.┘ (execute selected)
                       └main/seq  (change step)
```

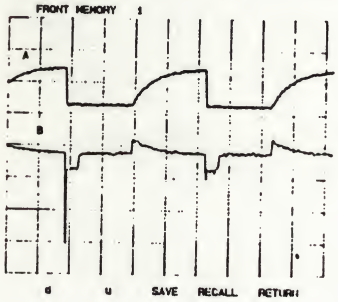
Arrange sequences for dedicated measurements

DEMO / HANDS-ON

Define 2 frontpanels and save them for later use

Both capturing the current and voltage
of a switching diode

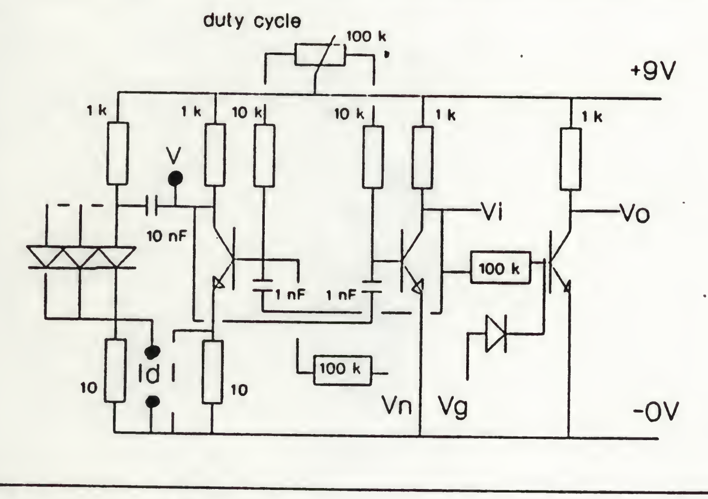
Define 2 frontpanels and save them for later use

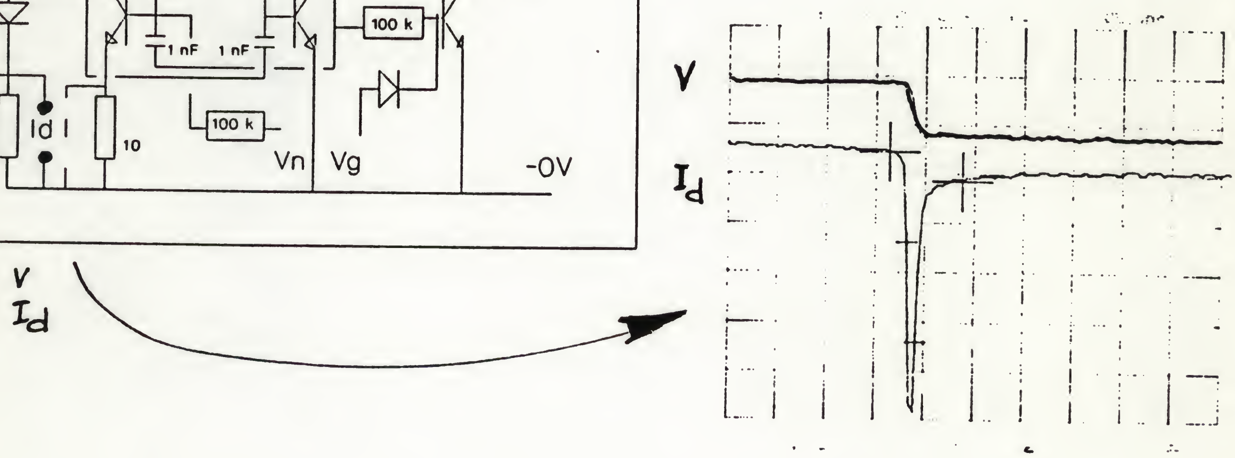


Use the Chopper Target

Zoom into the NEG areas
to define the REVERSE CURRENT

CHOPPER TARGET





SOFTKEY MENUS

MENU

VERTICAL

```
MODE ──┬─A,B,invert,etc.
       └─PROCESSING>──┬─min/max
                      ├─BW limit
                      ├─AVERAGE>──────C=x
                      └─ABS MIN/MAX>──┬─to Rx
                                      └─start/stop

COUPLING ──┬─AC,CD,GND,1Mohm,50ohm
           └─OFFSET>.......
```

MENU

HORIZONTAL

```
MODE ──┬─recurrent,single,multiple,roll
       └─DIFFERENCE>──┬─SAVE/STOP
                      ├─SAVE:Rx>
                      └─REFERENCE>──┬─restore R0 with
                                    │  ABS MIN/MAX
                                    ├─to Rx
                                    ├─up   | adjust
                                    ├─down | gap
                                    └─amp/time
```

MENU

TRIGGER

```
SOURCE ────A,B,EXT,slope,line

COUPLING ──┬─ac,dc,auto,TVF,slope
           └─EV/EXT CLK>──TTL,ECL,VAR,slope   (level events)

DELAY ──┬─time/div,value...
        └─EVENTS>──┬─events+delay
                   ├─delay only
                   └─number of events....
```

MENU

DISPLAY

```
[ ]       ┌─Reg select>──────Rx
DISPLAY   ├─Pos Rx──────┬─calibrate      ┌─chan A
          │             ├─channel>───────┼─chan B
          │             │                └─calibrate
          │             │
          │             │        ┌─analog   |
          │             └─plot>──┴─digital  | SCREEN !
          ├─invert>...
          ├─A versus B       ┌─front
          ├─Full>────────────┼─results (dX and dY)
          │                  ├─Rx (full text of REGx
          │                  └─text off
          ├─channel identifier
          │                          ┌─IEEE>...  | set up
          └─option>─interface>───────┼─RS232>..  | plot channel
                                     ......
```

```
[ ]       ┌─expand,compress (horizontal)
MAGNIFY   └─Y*5,Y*1,Y/5     (vertical)
```

MENU

MEMORY

```
[ ]         ┌─save to Rx
SAVE/PLOT   ├─ANALOG>...   | plot to analog/digital controlled
            ├─DIGITAL>...  |      device
            │
            │           ┌─Rx (register to be plotted)
            └─SELECT>───┤
                        ├─ANALOG> ..  | SET UP plotting
                        └─DIGITAL>..  |  device
```